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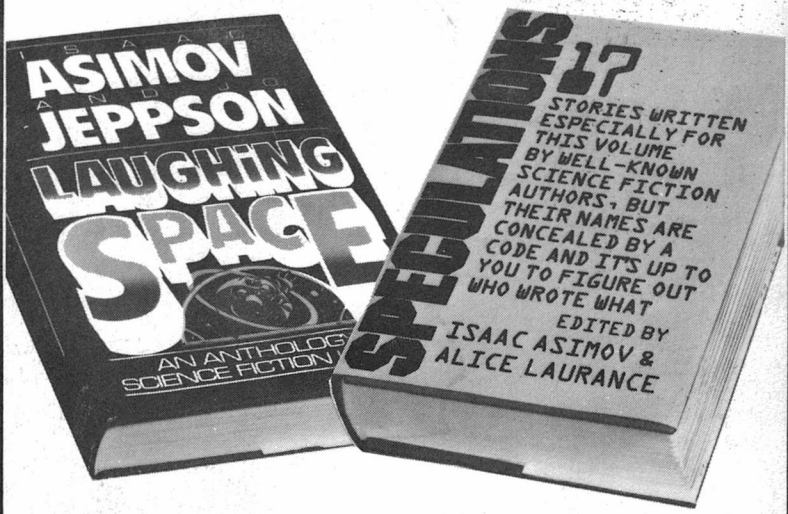

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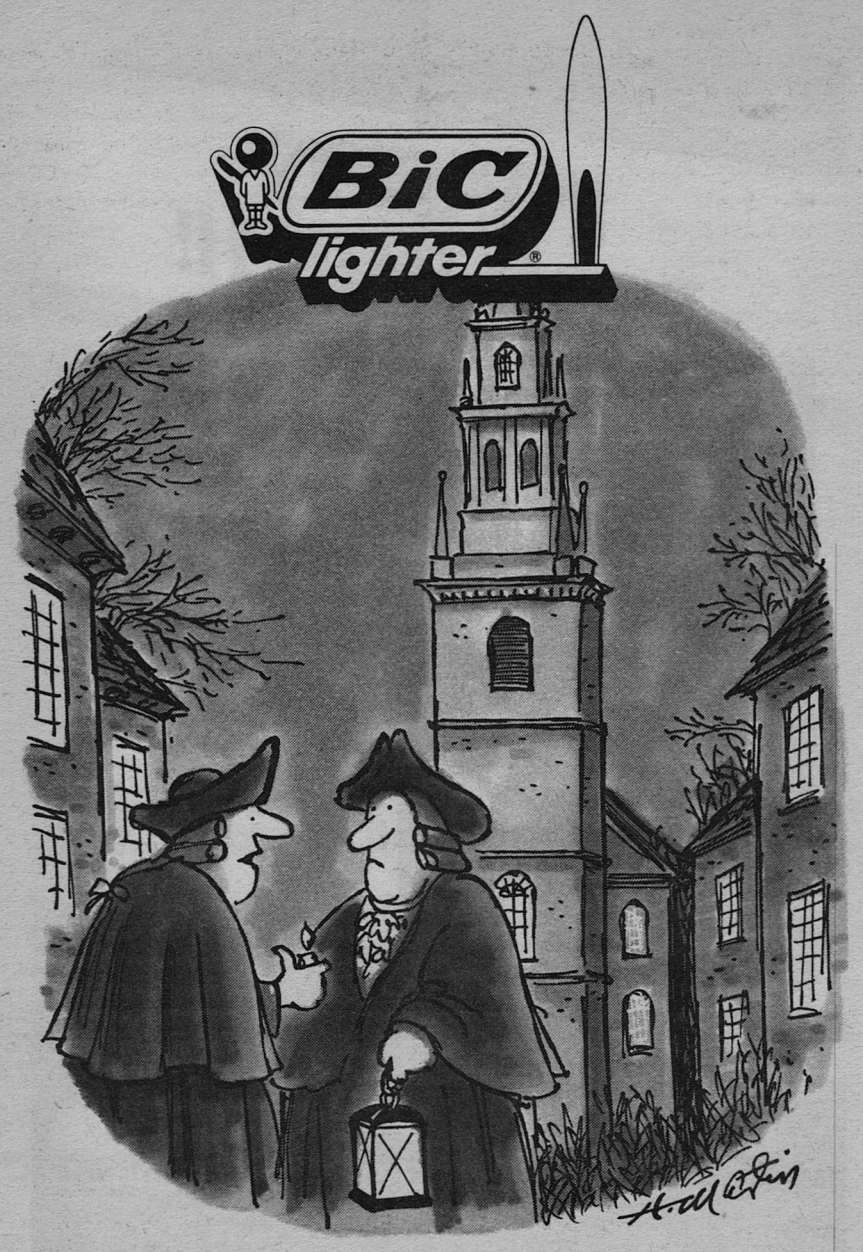

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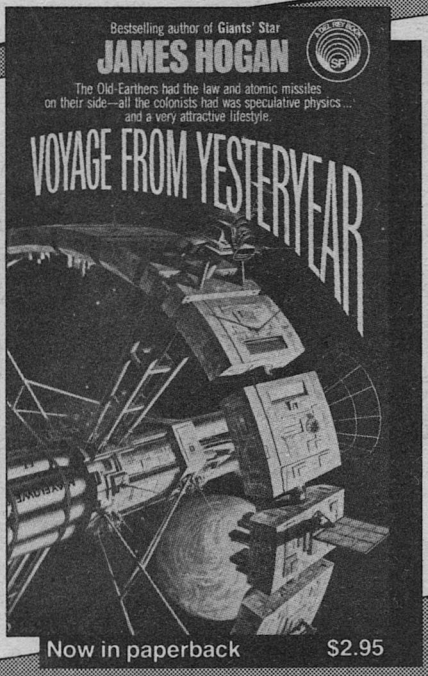

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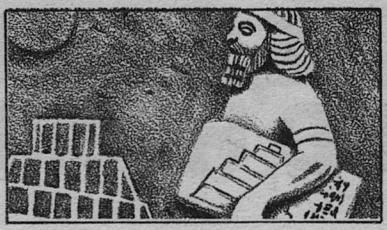

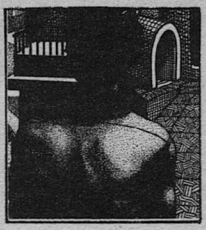

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Guest Editorial by Thomas A. Easton

IMAGE, REALITY, AND HUBRIS

American scientists today are caught in a perplexing bind. On the one hand, the public looks to them for solutions to a multitude of problems born of the needs of a large population for food, raw materials, and energy. These problems include waste disposal, pollution, pesticides, gasoline shortages, and even inflation and unemployment. All are related, and if they would not exist save for past technological and scientific progress, they also would not exist if people did not demand the fruits of that progress.

On the other hand, there is a strong sense of distrust of scientists in general. People see them as greedy devourers of public funds bent on "working" at expensive hobbies—Senator William Proxmire is only one of those who delight in ridiculing research whose implications they cannot understand. People see them as arrogant—"Trust us," the scientists seem to be saying. "We know the answers. We'll tell you what to do and think." People also see them as less than wholly dedicated to telling the truth—the scientists have loudly assured everyone that various things (pesticides, nuclear power, drugs, flame retardants) were safe to use, only to change their tune a few years later. People are even suspicious of scientists as frauds, and this suspicion has been immeasurably strengthened in the past few years—an anthropology department chairman was jailed for making drugs in his lab; other researchers have lost their jobs for faking research data or plagiarizing their research papers; a dead psychologist lost his position in his field's Hall of Fame when it was discovered that he had invented both data and coauthors; and more.

People do not like to subsidize idle curiosity. Nor do they like to be told, "Trust me," especially when the teller has been known to change his or her mind or has been caught lying. They insist on insurance for their trust. They demand guarantees of safety for new products and old, for automobiles and nuclear power plants, for drugs and pesticides, for food additives and occupational exposures to a host of substances. Only when they see the product in question as necessary to life as they wish to live it, as they do with the automobile, do they mute their cries. Even then, their spokesmen in Congress translate their demands into a multitude of regulations intended to reduce the citizenry's risk of harm. Thus were born

the Food and Drug Administration, the Occupational Safety and Health Administration, and the complaints from American industry that its ability to compete in the world is being strangled.

Yet at the same time there is a strong faith in the ability of science and technology to improve life and solve problems. In Europe, one poll showed that 69 percent feel that science is "one of the most important factors in the improvement of our daily life"; oddly, the percentage was lower in Germany. In the U.S., polls put scientists as second only to physicians in the public esteem. When asked whether science and technology have changed life for the better, 71 percent said "yes"; only 7 percent said the change was for the worse. When asked who to blame for various problems, 60 percent said "government decision-makers" and 14 percent said "business."

Looking at the same sentiment in another way, Louis Harris and National Opinion Research Center surveys for years have asked people how much confidence they had in science. They found in 1966 that 56 percent said "a great deal." By 1971 that figure had dropped to 32 percent, perhaps because of the war in Vietnam, but since then it has risen again. At no point have more than 10 percent said they had no confidence at all in science.

Still another angle comes from newspaper readership surveys by the Newspaper Advertising Bureau. They find that people want to read more than they usually find in their papers on science topics, especially in areas of applied science such as energy, health, and environment. This does not, admittedly, say much about whether people like or trust science—people are as avid for news of what they fear or hate as for news of what they love. But it does suggest that, whether they see it as good or bad, people do believe science is important to their lives.

So why are scientists in a bind? It may be partly because of the poor image the media grant the scientist. Ben Bova has said that, in movies, "scientists are portrayed as having moral sensitivities no higher than a Hollywood producer's." Carl Sagan has remarked that, on the Saturday morning cartoons for our impressionable children, many scientists are "moral cripples driven by a lust for power or gifted with a spectacular insensitivity for the feelings of others." David Gerrold credits at least some of this to the fact that the media use few scientific advisors. It seems that scientists are rarely willing to make the compromises with the truth that may be necessary to the realities of producing a show. It also seems that many producers feel little need for scientific advisors— think scientists really *are* nuts.

More to the point, perhaps, is public disillusionment with inadequate prophecies. Lewis Thomas, president of the Memorial Sloan-Kettering Cancer Center in New York, has said, "We have often made it seem as if we are almost there, and, with a bit more effort and more funding, we will be home and dry, knowing everything. Also, we have made too many promises, too explicitly and of too short a term." He was writing about cancer research, but his words go for other fields as well, for fusion re-

search and crop breeding and space travel. They even apply on a more mundane level: if your car's mechanic tells you, over and over again, "Give me another $100, and tomorrow you'll be on the road again," you will soon distrust him, no matter how much you are forced to admit you depend upon him. You learn to be skeptical, distrustful; especially if, though he gets your car running, you have to put it back in the shop within a week.

Related to this is the role of "bad science." Cyril Comar, a Cornell professor emeritus, defines this as "whenever hard conclusions from scientific investigation are not warranted by the data or the data are misapplied." Bad science thus leads to bad decisions and sometimes disastrous consequences. For instance, evidence that artificial sweeteners are weak carcinogens nearly got them banned, a bad decision from the point of view of many calorie-counters. For another instance, evidence of the hazards of radiation has been used to ban the disposal of even weakly radioactive waste materials in many areas, no matter that the hazard from these materials, properly handled, is minimal and no matter that their disposal is essential. For still another instance, though an older one, heroin was invented as a nonaddictive substitute for the painkiller morphine (hence the "hero" in the name); it was widely distributed before its addictive potency was recognized, and it created large numbers of addicts.

Many more examples exist, and many more may appear in the next few years. There are now—as there have always been—competitive pressures among researchers. "Publish *first!*" is the cry. "Stake your claim." Jumping to conclusions is thus not at all uncommon. It is somewhat less common to see it in most scientific journals only because these journals follow the practice known as refereeing or peer review.

Yet not all reports of scientific research are refereed. Some journals don't use the practice; since they thus can publish a paper more promptly, they are often used by researchers eager for publication. Some reports are given orally at scientific meetings or to congressional hearings. Some are even issued as press releases. None of them get checked except after the fact, by which time whatever damage might be done often has been done.

This problem is growing, especially in the form of reports to congressional hearings, where firm conclusions and recommendations are much in demand. Members of Congress have long bemoaned the fact that scientists called on to testify before a committee will say one thing, perhaps quite satisfying to the committee members, and then add, "On the other hand . . ." Senators and representatives would love to have more "one-armed" scientists, even though the truth *is* often conditional.

Why does Congress even ask scientists to testify to its committees? Simply, Congress sees its job in part as ensuring the public safety. It wants to be sure that hazards are suitably appraised and regulated. It wants to use the best available information in its approach to this task, and that means going to those who produce the information: the scientists. By and large, it even gets the information

it wants, if not immediately, then after it has ordered and funded an appropriate commission, study group, or research project. The information may even be of good quality and uncontaminated by controversy.

Yet scientists are only human. Some are as arrogant as the public perceives them all to be. Some are as machinelike as the media would have them. Some have questionable morals. Most of them, however, are keenly aware of their responsibilities to truth itself and to those who seek the truth of them. They recognize that truth is a conditional thing, subject to qualification, amplification, and even reversal as more is learned. They do not pretend to hold some revelation from on high; they are not arrogant, but humble.

If they seem otherwise, we can look to the pressures upon them. They compete with each other for priority. They compete for research funding and academic promotions, both of which often depend on the length of the individual's list of previous publications. They feel burdened by the demand of public and Congress for information.

It is easy to understand how some scientists may find themselves making up data, plagiarizing, and jumping to conclusions. Like us all, they wish to relieve the pressures upon them, to lengthen their publication lists, to provide demanded information. That this may indeed be the explanation is suggested by the fact that more cases of fraud and plagiarism have appeared in recent years—even as the academic job market has grown tighter, research budgets have grown leaner, and "con-

sumerism," with its insatiable demand for information, has grown. Yet some observers claim that fraud and plagiarism are no more prevalent today than ever. What has changed, they say, is the frequency with which these crimes reach the media. The intensity of competition affects the scientific sinner less than it does the stool pigeon who, by squealing to the authorities, removes an obstacle to promotion or funding.

The equation of pressure with crime fits cases such as that of William Summerlin. In the early 1970s he claimed he had found a way to make skin transplants take, even when the animal from which the transplant was taken was genetically very different from the recipient (skin and organ transplants are normally possible only between genetically similar or identical animals). He said, in fact, that he could transplant skin from a black-furred mouse to a white-furred mouse, to produce a white mouse with a black patch. Pressed to prove his claim and feeling his job on the line, he showed off a black-patched mouse. However, his boss immediately found that the black color came off on his fingers. Summerlin had produced the mouse with the aid of a felt-tip pen. He was canned.

The equation of pressure with squealing may fit better the case of John Buettner-Janusch, once the chairman of the New York University anthropology department. Some time after the National Science Foundation cut back his funds, he began making Quaalude, LSD, and synthetic cocaine in his lab, using graduate-student labor and NYU-purchased raw materials. He was turned in to the narcs by one of his departmental col-

leagues, who thus cleared the upper level of the department of an often abrasive personality, made room for promotions, and liberated funding for other uses. It is doubtful that Buettner-Janusch hoped to replace his lost funding with the proceeds of drug sales; he wasn't making that much.

But what about the cases of Elias A.K. Alsabti, a Jordanian who has plagiarized, been caught and fired, and changed jobs time and again, or of Vijay Soman, who made up some data so he could finish a paper in a hurry? Alsabti sounds pathological. Soman, who might never have been caught had he not also plagiarized some 60 words, sounds almost normal. Practically everyone —Newton, Mendel, and lesser lights as well—has fudged the data to make things come out even. Filling in blanks is almost as common—if somewhat more reprehensible, less honoring, of the scientist's responsibility to truth.

We need a more general explanation of scientific wrongdoing, and we may find it in egocentricity. Scientists are taught that they are the discoverers of the only truths that really matter, the repeatably observable facts of nature. All else, though it may be worthy, is but subjective illusion. They are given credit for civilization, health, progress—you name it. It is thus, perhaps, no wonder that some scientists come to believe that their thoughts are the only ones that matter, that truth is what they say it is, with or without the laboratory. It is no wonder that some scientists become proud, that they set themselves up as an autonomous, unaccountable standard of behavior. It is no wonder that some feel justified in jumping to conclusions or making up data. After all, they know they're right. Why should they waste time on "extra" experiments?

The pride that challenges the gods was once called *hubris*, and it was an

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essential component of classic tragedy. Today, however, we recognize few gods. Their place has been taken by what we may call the conventional wisdom or morality, the will of the people, professional ideals, and the like. He who challenges these modern rulers of behavior indeed sets himself up for tragedy and is as guilty of hubris as any Greek hero.

Clearly, the too-proud scientist is the one the public knows from the media, the one whose morals are those of a Hollywood producer and whose sensitivity to others is nil. He is the one whose arrogance the public knows and distrusts.

Yet in this scientist the public knows only the man or woman in whom original sin is alive and strong. The public does not know the vast majority of virtuous scientists: those who, though they may lie, steal, murder, and cheat on their mates (they don't, of course, any more than the rest of us), recognize the responsibility of the scientist. They have two arms, and sometimes more. They test their ideas thoroughly. They are cautious about conclusions, even when government regulators demand facts firm enough to stand an elephant upon them. They are egocentric—they were taught so—but not to the extent of denying the validity of other viewpoints or of insisting on their own primacy.

The frauds, plagiarists, and other scientific sinners are unfortunate. They give science a bad image. But they are unavoidable—hubris *is* the original sin—and they must be lived with. Their acts can be prevented no better than can other crimes, but they can be caught and the perpetrators expelled from the society of their peers.

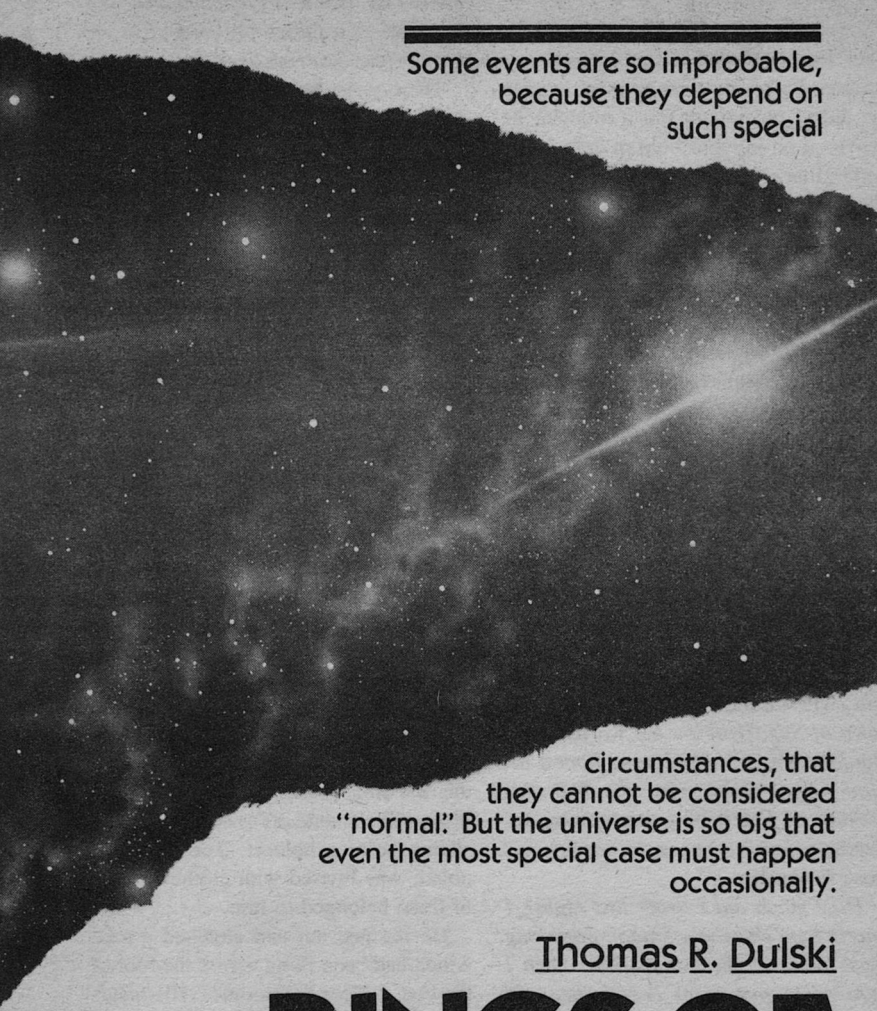
What else can we do? The media are unlikely to change their favored image—virtuous, responsible scientists, like nonheroic soldiers and honest politicians, are just not colorful enough. The competition for position and funds is not about to ease. The public and Congress are not about to stop their demands for facts firmer than honest scientists can offer. The urge to sin, the pressures that can turn egocentricity into hubris, will remain.

Does it really matter whether we do anything? Perhaps not. The public may not trust, but it does have confidence, say the polls. There is a paradox there, a puzzle, but it may only mean that the public feels a need for the results of science even as it recognizes that scientists vary in virtue, just as do businessmen and politicians and physicians. Its distrust may in fact be founded in uncertainty, in the basic question of how to tell the sinners from the saints. ■

● No crossword puzzle fanatic has ever been an arsonist, bigamist, or turncoat. Very few have pleurisy or sciatica. None has ever used "have" for "has" in this sentence. Most know that fulfilment can be spelled with one "l". Some have, of course, gone mad.

Henry Morgan


Rick
Sternbach



Some events are so improbable, because they depend on such special circumstances, that they cannot be considered "normal." But the universe is so big that even the most special case must happen occasionally.

Thomas R. Dulski

RINGS OF GLORY

I

Jack Deiner awoke to find himself in a strange bed lying next to a fat woman he didn't recognize. For a moment he wavered on the threshold of dream, the unfamiliar impressions blending with the shards of sleep. Then the fat woman stirred, a lock of her hair dropping across the bridge of his nose, and Jack Deiner was fully, painfully, awake.

"Oh, my God!" he whispered to himself. He was still drunk, he realized, with a stupendous hangover to look forward to. Already he could feel the approaching edge of nausea and a distant throbbing in his head.

He lay still, afraid to move until he had taken stock of his situation. *Where am I?* he thought. *Better yet, who am I? And who is this next to me?* The woman's hair was beginning to make his nose itch.

You're Jack Deiner, he said to himself, without much pride. *You're in the town of Sugarville on the world called Banjoqueen. . . . And you, honest-to-God, don't know who the hell this woman is!* The itching was getting unbearable and he began to wrinkle his nose furiously.

How much did I drink last night? I was in the Yellowcake Saloon—drinking beer alone at the bar at first. Then I won some money at darts when old Mishka and his sons came in. I remember that much. Then they left . . . Somewhere during the evening I switched to the hard stuff . . . Jessie Macronazi started a fight with somebody and they threw him out . . . Then—who was it?—Tom Appleton, the big guy who struck it rich a year or so ago—he showed up with a girl on each arm. We sat down at a table—the four of us. It was obvious that Tom liked this one . . .

There were lots of blanks after that point, Jack realized. Somehow, he ended up alone at the table with the other girl. They drank and laughed. Talked about all kinds of crazy things. A staggering walk, arm-in-arm through the night streets of Sugarville. Company cops peering at them from a patrol hovercar. A flight of wooden steps. Singing in each other's arms . . .

Jack opened his eyes and saw the fat woman looking back at him. "Good morning, love," she said.

"Ah . . . good morning." Jack sat up quickly and the room did a somersault before his eyes. At the same time a wave of nausea rolled over him.

The woman sat up too, holding the covers demurely about herself. There was a concerned look on her face. "Are you okay, Jack?" she asked. "You look really pale."

When his vision cleared the room they were in revealed itself to him for the first time. A shabby one-room apartment—kitchenette off to one side, a few chairs, sofa, a holoset. The floor, he noted, was littered with clothes. Some of them belonged to him.

He reached out and clutched a robe which had been flung across the foot of the bed. "Your bathroom?" His hands were trembling as he struggled into the robe.

"The white door off to the right," the woman told him.

When he stood up his head began pounding with serious intent and a tsunami of nausea propelled him to the bathroom.

When he emerged almost an hour later, the woman was in a housecoat beating some eggs in a bowl with a wire whip. She was humming merrily to herself.

Jack felt a little better, but was still walking a tightrope between intoxication and hangover.

He steadied himself with one hand on the crazed plastic surface of the wall and walked over to her.

"Feel any better?" she asked, noticing him. "Think you could eat some nice scrambled duck eggs?"

"No eggs!" he almost gasped. He still couldn't remember her name.

She was amazingly well, considering the amount they had drunk together. *Maybe she only pretended to be drinking,* he thought. *Got me drunk. Got me into this.*

"How about some citrojuice? Or some coffee?"

"Coffee. Black," he said, pulling a chair toward him and collapsing into it.

The woman placed a cracked mug down in front of him. "It'll just be a minute."

Jack pulled closer to the little fold-down table and rested his elbows on the plastic surface, his cheeks in his hands. He stared down into the recess of the empty mug and tried to coax his memory for more details about last night.

It wasn't working. He averted his eyes and watched the woman toss a handful of beans into a small coffeemaker. *She's really not so fat,* he said to himself. There was a whirr and a hiss of steam.

"Here you go," she said, bringing the metal unit over and pouring under his nose. "Just what the doctor ordered."

The smell, anyway, was inviting. Jack took the mug in both hands and drank.

The woman sat down across from him with a plate of scrambled eggs and began to eat delicately.

After a minute she said: "You know, we really know very little about each other."

Jack felt another wave of nausea at this point, but fought it back with a swallow of coffee. A moment passed while he thought about her words. "W-why should we?" he finally got out. "I mean we just met last night, right? I-I mean we're not married or anything . . . Right?"

The woman stirred her eggs with her fork. "No, but you said some things last night . . . You know that was really beautiful for me—the whole night . . ."

Jack looked at her but she wouldn't meet his gaze. *Pretty face, really. No spring chicken, as they used to say. Seemed a lot younger-looking last night at the Yellowcake . . . But I was pretty far gone. If she'd lose some weight, she wouldn't look half bad . . . If only I remembered more . . . Like her name . . .*

"You're right—what you said about not knowing much about each other." Jack drained his cup and reached for the coffeemaker. "Why don't you tell me about yourself? For instance: did you ever tell me your last name?"

"Petulack. Tina Petulack."

Tina, Jack thought. *Okay, now we're getting somewhere.*

"There's not a great deal to tell about me," Tina said. "I was born on a little

colony world you probably never heard of—Olive I. My parents were prairie farmers. They grow an oil-seed plant there, something like a sunflower.'' She took a mouthful from her plate, then set her fork down.

''I was bored as a kid. There was nothing to do there. My folks were very religious and I guess I overreacted to that by being a little wild. I hitched a ride with a freighter-pilot. He was going to show me the big cities—you know, the showy places in the galaxy . . .'' Tina folded her arms on the table and looked at him with a dream in her eyes. ''I used to watch holotapes about Amadine, Neuholland, London . . . They all seemed so exciting compared to our little farm on Olive I.''

Her gaze dropped. ''I'm sure they are. I never saw them. This freighter-pilot . . . Well, he ended up not being very nice. And I ended up on Banjo-queen. I worked as a waitress, then a store clerk—even in the mines for a while, but that didn't last. I mean the pay was good, but I wasn't cut out to be a miner. The ventilation is never working right and you cough a lot . . . And the dirt—under your nails and in your hair . . . you never really feel clean. I guess you know what I mean?''

Jack nodded, halfway through his second cup of coffee.

''So I met this fellow—a prospector. He was very nice. We were going to get married. All he wanted was a small strike—you know, for a nest egg, and then we'd settle down together. I went with him several times out into the hills looking for uranium. I learned a lot: how to handle a survey meter, how to spot pitchblende. . . . We slept under the stars for weeks on end. We made up our own constellations. I remember Mother Sol was the eye of a donkey. Did you know that you can see Sol from here?''

''No, I didn't.''

''It's not very bright. Anyway, he never hit pay dirt—this prospector fellow. He left me one night. I woke up and he was gone. Just a note and some money he must have felt he owed me.'' Tina's voice fell to almost a whisper, but her eyes were dry. ''I still have the note.''

Jack rubbed the stubble on his cheeks. It was a little more than he had wanted to hear. Too personal. *She's an open and vulnerable chickie,* he thought. *Needs some salt-of-the-earth type to take care of her.*

''Your turn,'' Tina said, sipping at her coffee.

''Hmm?''

''We're exchanging life stories, aren't we?''

Jack wondered for a moment if he could beg off by virtue of another emergency retreat to the bathroom. He *did* still feel like there was a nest of worms in his stomach. ''Not much to tell,'' he said, at last.

''I'd be interested.''

She would, *too. Just the sort that would love a sad story. She'll roll her eyes and shake her head and I'll be in deeper than I am now.* ''About last night . . .'' he began.

''Not fair!''she said, setting her cup down. ''Look, I know you were drunk. I've been through this scene before. But I told you *my* story . . .'' She caught herself and bit her lower lip.

Christ, she's going to cry! ''Okay, okay.'' He managed a weak smile. ''I

just wanted to know how much you know about me already. . . ."

That made her smile despite herself. "Let's see," she said. "Your name is Jack Deiner and you've lived on Banjoqueen for almost a year and you beat everybody at darts."

"Not everybody."

"Well, you said everybody."

He winked at her. "Well, now you know something else about me. I lie."

She giggled and brushed back a lock of auburn hair. "Come on, Jack, it's show-and-tell time."

He drained his second cup of coffee with a wet slurp. "Okay, you asked for it," he said. "I grew up in an orphanage on Mizar III. A cold, dirty little world. Binary systems aren't supposed to have planets—something about the way protosolar clouds condense—let alone habitable ones. Mizar III just barely qualified as habitable, if you ask me. Water ice and frozen carbon dioxide. Big glaciers and frozen rivers of it. The atmosphere too—mostly CO_2 and water vapor—nothing you could breathe.

"The orphanage was a carryover from the days when the bubble-cities had been boom towns. Opalite, they called it—a gemstone with entrapped bubbles of gas. Turn it in the light and you saw shifting planes of color. A hundred years ago, they tell me, it was all the rage. Mizar III supplied all the jewelers of the galaxy with it. By the time I was born the market for it had disappeared. I remember seeing a big lump of it being used as a doorstop."

"So you never knew your parents?"

Jack ran his fingers through his tangled hair. "Oh, I knew them, all right. My old man was a roustabout driller who'd married a young girl half his age. I guess I was a mistake or maybe a foolish dream. There was no work for him there. I guess she ran off with somebody. What's a guy like that going to do with a six-year-old?"

Tina folded her hands on the tabletop. "Your father put you in the orphanage?"

"Sure. Why not? He scratched together enough money to book passage for himself out of there. He gave me a letter to give to them at the orphanage."

"Oh, Jack, that's really sad!"

Here we go, he thought. *Why am I telling her all this? Cut it short.* "When I was about sixteen I took a job as a baggage handler at the spaceport. Two years later I signed on as a deckhand on a merchant ship. That could have been a nice living, if I'd had any sense. I *did* get to see quite a few worlds—'Ceti, Amundson, Debbie III, most of the Near Arm . . . But I got the itch while we were laid over on Deephole. I was still in my early twenties. I was in a bar minding my own business when a group of characters walked in—a Dringad, two Mendelkinder, and maybe four or five humans. They were yelling and laughing, grinning from ear to ear. Except, of course, for the Dringad. I never saw anybody throw money around like that. They were a bunch of miners who'd got some cash together between them and quit their jobs to go off prospecting together. They'd hit a big strike—a copper sulfide loaded with platinum-group metals. They were all millionaires overnight.

"That was all I needed. I quit the merchant marine, got some supplies together and struck out on my own. I spent

the next ten years scrambling up and down the mountains on Deephole. Like your friend—the guy with the note—I never did strike it rich.'' Jack looked up into Tina's sympathetic eyes. ''Oh, a nugget of something, here and there. Just enough to keep me believing that any day I was going to trip over a mother lode.''

Jack sat back and the plastic chair creaked under his weight. ''Well, it never happened. And I woke up one morning in a smelly sleeping sack in a cold rain and suddenly realized that I was thirty-four years old and starving. I took a job in the mines digging rutile. Three years later I was a turn-foreman. Most of the older workers accepted it okay, but a few of the young kids with just a few years more seniority than I had—they wanted to know why I got the job. One of them came after me with a laser pick.'' Jack unconsciously touched his right shoulder where the robe hid a shiny streak of scar tissue. ''The front office didn't want any union trouble. I was management now—low-rung management, but management. The easiest thing was to fire me.''

''So you came to Banjoqueen looking for work?'' Tina's expression remained serious.

''Right. Only the incident on Deephole is in my computer file. I've been all over this planet—Johnson City, Paydirt, Kimberlite—the mining companies won't touch me, even as a laborer. There's too few jobs and too many people looking for work. They don't need much of an excuse to turn you down.''

Tina got up and carried her plate to the washer slot in the sink. ''Sounds to me like you should have filed an appeal with the labor office on 'Ceti,'' she said. ''I mean, it wasn't your fault, and they're supposed to take care of those kinds of things.''

Jack winced inwardly. He had, of course, colored his story about the incident on Deephole. The young miners had been verbally abusive and Jack had punched out the lights of two of them before the third had reached for the laser pick. His computer file, he was sure, had the story right. He was marked as a hothead, possibly as an incorrigible—not the sort of person he was at all.

Jack got up from his chair slowly and was relieved to find that the room remained stationary. Noticing the drawn drapes next to the holoset and anxious to change the subject, he said: ''What kind of a day is it out there, anyway?'' The line of sunlight on the floor warned him to be cautious. He padded across the rug, fixed his eyes in a squint, and parted the cloth.

A backstreet of Sugarville glared back at him in all its seedy glory. He looked down on an array of metal junk piled against the building three stories below: rusting treads from a swamp-car, somebody's broken sonic washer, a kid's tricycle with no handlebars. Brightly colored wash flew like flags from a balcony down the street. At the intersection with the main thoroughfare he could just discern the flash of a passing hovercar.

''I think it's supposed to rain this afternoon,'' Tina said, still tidying the kitchen area.

The sky was its characteristic bright blue-green with a few scattered wisps of clouds. Jack let the drape fall back

and watched red after-images float before his eyes.

Cautiously, he negotiated a path between the sofa and a battered coffee table in search of his clothes. He found that Tina had folded them and arrayed them on the bed, which was now neatly made. All while he had been in a passionate embrace with a porcelain fixture.

He glanced groggily toward Tina, who was now humming to herself again. Then, beset with unaccustomed modesty, he picked up the neat piles and entered the bathroom to dress.

It was only moments later that Jack reappeared, still barefooted and naked to the waist. He was searching his pants pockets for the third time and suddenly very awake and sober. "Two hundred credits! I had two hundred credits in my pockets! And a gold money clip!" *And to think I was going to leave her a few bills just to be nice! That fat slut!*

Tina ran over to him, her face suddenly a distorted mask. "God, Jack, you don't think I took it!"

He was still fishing furiously for what he knew was gone. "Every credit I had!" he raged. "What am I supposed to live on!"

Tina was crying openly now, her face like a child's. "I didn't take it, Jack! Honest to God, I didn't take it!" She had stopped a few paces from him, seemingly afraid to approach closer. As if he might hit her.

It took Jack aback a little, but the anger was still boiling in him and he couldn't stop the words: *"Well, if you didn't, who did?"*

"I don't know . . ." Tina said between sobs, ". . . maybe at the saloon last night . . ."

"Don't hand me that!" But he saw that the frightened middle-aged little girl hadn't taken the money. *Shut up, you ass-hole,* he said to himself. *You're scaring her.*

"I didn't take it!" Tina wailed. "I didn't take your money!"

"Okay," he said, his anger extinguished by pity for the child in the woman's body. "Okay, okay, I know you didn't." He took her in his arms and felt her tears on his chest. She was trembling and sobbing.

"Hey," he said, rubbing the back of her housecoat. "Hey, cut it out"

"I . . . know how it looked," she said, stifling a sob. "But I didn't . . . I couldn't . . ."

"I know, I know," Jack said. "I flew off the handle. Let's forget about it, okay?"

"But your money . . . We, we've got to go back to the Yellowcake . . . you must have lost it there . . ."

"You really want to go along?"

"Sure, Jack."

Jack looked into her brown eyes, still wet with tears, and saw a child-like sincerity there. It made him feel good, but he didn't know why.

"Tell you what," he said. "Let's get dressed and see if we can find that money."

She smiled and kissed him then. And that felt good too.

II

The Yellowcake Saloon was a monument to an era when Banjoqueen had

first begun to yield its mineral wealth to the galaxy. Fifty years before, when its lead crystal chandeliers and gold leaf balustrades were new, the rich and the powerful had dined here on fine cuts of "buffalo" steak, gleaned from the limitless herds of this Miocene world. Built as a grand gesture by a long-since-departed man who had made his fortune in uranium processing, the Yellowcake had gradually lost its original luster. The fine wines from Earth passed first, then the *haute cuisine*, each replaced by coarser stuff. The dancehall shows took on a bawdy touch and gambling went from "gentlemen's games" to darts and bar dice. Finally, the Yellowcake became what its facetious name had destined it to be: a saloon.

A saloon in the early afternoon was no sadder here than on any other world. In the dimly lit interior of the Yellowcake, scattered small groups huddled at tables, shielded from the light of day. A small autovac whirred quietly among the empty tables, still gathering the refuse from the night before. The lone bartender was watching three-inch figures worry over a ball on the holoset, the audio muted to a low murmur.

Jack and Tina both felt as though they had entered a darkened theater and they stood a moment just inside the door waiting for their vision to return.

"Are you going to ask the bartender?" Tiny felt compelled to whisper in the sepulchral atmosphere.

Jack squinted through the darkness toward the bar. "That's not one of the night men," he said, "but I might as well ask. Be right back."

Tina waited as Jack weaved a path among the empty tables, carefully avoiding the bustling metal cannister of the autovac. She watched as he stepped up to the bar and interrupted the bartender's preoccupation with the holovised roundball scrimmage. There was an exchange of words she couldn't hear. Then a short laugh from the bartender that echoed in the silent room. A few heads looked up from some of the tables.

Then Jack's voice rose, colored by anger—the words still indiscernible. Tina felt herself growing uncomfortable. *Don't make a scene, Jack,* she thought.

The bartender's voice was rising in anger too. He was leaning on the bar, his face only inches from Jack's. Most of the assorted denizens of the Yellowcake were openly staring now. A few glanced toward Tina standing near the doorway.

Tina was torn by two impulses: to turn and leave, erasing the scene with the sunny and familiar street outside; or to walk up to the bar and intercede in some way. It was a familiar feeling, she knew. How often in her life had she turned and fled from ugliness?

Jack was almost yelling now—oaths she'd heard in the mines and elsewhere. The bartender's hand had dropped below the bar, perhaps groping for the stunner they sometimes used to handle belligerent drunks.

Tina found herself moving toward the bar, her heart pounding. Chairs clattered in her path as she stumbled through the maze of empty tables. *Be nice, Jack. Please, be nice!* In a sense, it was all she'd ever asked of her world.

Just as she neared the mounting argument, a massive wall of a man

blocked her view. A dingy grey shirt, like a curtain hanging loosely from enormous shoulders far above her head. Not a man, she realized.

The Mendelkind's voice was deep, but soft. There was a weary calm to it and just the faintest trace of a lisp. "Take it easy, friend. Joe here doesn't have your money."

Tina stopped in her tracks, noticing that one of the Mendelkind's enormous hands was wrapped around Jack's shoulder. The giant was totally bald and a series of skin-folds made a washboard of the back of his neck.

"Don't hurt him!" Tina said.

The Mendelkind turned slowly and looked down at her. His hand remained where it could crush Jack's scapula, the grip firm but causing no pain. "Beg pardon, missus?" the Mendelkind said.

Tina summoned her courage and set her face with determination. "Jack . . . he flies off the handle sometimes. He's not like that, really. You see, the money he lost . . . it was all he . . ."

"Tina, stay out of this!" Jack tried to turn around, but the huge fingers held him in place.

" 'Name's Brightbar, ma'am," the Mendelkind said. Huge blue irises regarded her from a face like a stone monument. But there was a warmth in those eyes that extinguished Tina's fear.

"M-my name's Tina and this is Jack."

Brightbar released his grip on Jack's shoulder so that he could turn around. "Pleased to meet you," he said.

Jack straightened his shirt and ran his fingers through his hair. The bartender, Joe, was still regarding him suspiciously, his hand still hidden below the level of the bar.

"He shouldn't have made a joke out of it," Jack said, his back now to the bartender.

"I'm sorry about your money," Brightbar said. "Honest, I am. But you really can't expect people to turn in 200 credits that they found. Not the times being what they are. Joe, here, he makes a joke out of everything."

Jack was silent at that.

Brightbar regarded them both, the huge face unreadable. Then he said: "You two look like nice folks. What say you come over to our table and have a drink on me?"

"No thanks," Jack said. "You don't have to . . ."

The Mendelkind smiled just a little. "Come on," he said, "I'll introduce you to Dobson. He's sort of an interesting guy."

"Look," Jack said, "thanks a lot and all that, but I've got to find that money."

Brightbar looked at Jack, then at Tina.

A giant, Tina thought, despite herself. *Jack and the giant. But a friendly giant.* "Why don't we, Jack?" she said. "I mean, maybe Mr. Brightbar has some idea about how you can find your money."

"Just Brightbar, ma'am," the giant said. "Some folks used to be touchy about the *mister.*"

Tina blushed. It was true and she knew better, but it had just slipped out. The Mendelkinder were the products of genetic engineering. Even though most of their genes were human, they were "not of woman born." The original intent, centuries ago, had been to mass-

produce "bottle babies" to provide a first-wave of colonists exactly suited to the environment of a new world. They were supposed to have been sterile, so that their occupation of the colony would not extend past the first generation. The "true-men" who comprised the second-wave were supposed to move in then, taking over a colony with all the buildings erected, all the toilets functioning—all the amenities in place.

It didn't turn out that way. Over time, it was discovered that some of the Mendelkinder were not sterile. They didn't quiescently die off on cue. Divergent genetic lines were created from the few who could reproduce. The experiment was stopped long before Tina was born, but the Mendelkinder and their descendants would go on alongside the race of men, marked by their appearance and by certain introns and exons in their DNA, and marked by the suspicions and fears of the "sons of Adam" who first gave them life.

"I-I'm sorry . . . Brightbar," Tina stammered.

The big face smiled. "Doesn't bother me a bit, ma'am. I just didn't want you to get in the habit of using that 'mister' and then . . . Well, there's all kinds of people about these days. . . ." Brightbar looked at Jack. "How about that drink?"

Jack forced a weak grin. "How about some citrojuice?" he said. "I've still got a head from last night."

"Too much of the joy-juice, huh?" Brightbar said, directing them towards the back of the bar. "Well, I know what you're talking about. 'Been there myself enough times . . ."

In a dark corner of the room a thin, unshaven man was sitting at a table with a stemmed cocktail glass in front of him. "Dobson," Brightbar said, "I'd like you to meet two friends of mine."

The man rose as Jack and Tina introduced themselves. "Alfred S. Dobson, Jr. I am pleased to make your acquaintance." He bowed with exaggerated manners that the Yellowcake hadn't seen for many years.

The four sat down and Brightbar motioned to a bored waitress who was leaning on the doorway to the kitchen. "Care for anything to eat?" he asked as she threaded her way toward their table.

"I think you should eat something, Jack," Tina said.

After some coaxing, Jack agreed to a sandwich and a glass of juice. Tina wanted citrojuice; the others ordered drinks.

"I couldn't help overhearing part of your plight," Dobson said when they had all been served. "These are indeed perilous times. Pickpockets and cutpurses abound on a world like Banjoqueen. I, myself, was once accosted by scurrilous youths. But, tell me, Mr. Deiner, what is your profession?"

Jack found that he was hungry and was in the middle of a mouthful of sandwich. "Well," he said, "I've been a spacehand and a miner, but mostly a prospector on Deephole."

"Ah," Dobson said, sipping at his cocktail, "an entrepreneur like myself. I was once an actor on the holos—you may have heard of me . . . no? Well, it was some time ago . . . I worked in finance for a short time, but there was an unfortunate incident where I was unjustly accused. . . . Well, since then I

have knocked about—human flotsam on the galactic currents, as it were. Wine merchant, importer, even a door-to-door salesman. Always, it seemed, the jealous greed of others would thwart my ambition. Wanton avarice is terribly prevalent, don't you agree, Miss Petulack?''

Tina studied the man over the rim of her glass of juice. *So thin,* she thought, *almost like he was starving. And he talks so strange. And he talks a lot. Well, I guess some people think I talk a lot, too.*

''I don't know,'' Tina said. ''Sure, there are some greedy people . . .''

Dobson scratched at the stubble on his chin. ''Perhaps it has been my misfortune to make the wrong friends.'' He smiled, then, very broadly, and it seemed to freeze on his face. ''Now that I've met you and Mr. Deiner and Brightbar, here—now, I believe my luck has changed. Oh, Brightbar—if I might have a word with you in private . . .''

The two got up from the table and conferred out of earshot near the door to the restrooms. Jack and Tina looked at each other, but didn't speak.

Jack was just finishing the last of his sandwich when they returned. ''Have you ever handled a big ship?'' Brightbar asked him.

''Launches and shuttles in the merchant marine. How big do you mean?''

''Two-man caravel,'' Brightbar said. ''Big cargo bay.''

Jack leaned back in his chair and knitted his brow. ''What's this all about?''

Dobson spoke up: ''It's *only* the opportunity of a lifetime, Mr. Deiner! The ship is fully automated—you would only be required to monitor the program that operates it.''

''Yes, but a caravel!'' Jack said. ''That sounds like a big . . . Wouldn't I need some kind of pilot's license? Are you offering me a job? Is that it?''

Dobson folded his hands on the table and leaned forward confidentially. ''Not a job, Mr. Deiner, an opportunity. An opportunity to make more money than you'll be able to spend in twenty lifetimes!''

Tina watched the anger flicker across Jack's face. ''What are you guys trying to pull?'' he said. ''Nobody makes an offer like that to somebody they hardly know!''

''I fully understand your skepticism,'' Dobson said. ''In your circumstance I probably would have reacted in the same way. But believe me, our offer is genuine. We are pressed for time because the ships we have in mind will be available for only a short time longer. . . .''

''Ships! You mean more than one?''

''It's not just that,'' Brightbar said, his chair groaning as he pulled it nearer the table. ''There's two kinds of dirt-diggers in this galaxy, the way I see it—the kind that dig for pay and the kind that dig for riches. I'm one of the fools who dig for riches and I think you're that kind too. On top of everything else, I got a feeling about you two—I think you're good people.''

Jack looked from Brightbar to Dobson, then back again. ''Okay,'' he said, ''I'll hear your story, anyway. What's this all about?''

''Did you ever hear of glory rings?'' Brightbar asked.

''No,'' Jack said.

''I did,'' Tina told them. ''Somebody was talking about them once when I

worked in the mines. Some kind of a strange planet, isn't it? It sounded more like a fairy tale, the way they talked about it.''

''Indeed, a fairy tale,'' Dobson put in, ''complete with a pot of gold.''

''They exist, all right,'' Brightbar said. ''Though you can count on your fingers how many people ever saw one. And you're right, miss, they have to do with a strange planet—a gas giant. Ever hear of Saturn?''

''One of the planets that circles around Mother Sol,'' Tina said. ''I saw a picture of it once—it's like Lanamite in the tau Ceti system—thousands of concentric rings around it, made up of little pieces of ice.''

''Well, glory rings are very special rings, miss. Very special.'' Brightbar's large blue eyes held a twinkle. ''The planets with glory rings around them have only ever been found in very young solar systems—nobody seems to know exactly why. Glory rings *are* gold, like the man said, *and* platinum, *and* iridium, *and* uranium . . . and, you name it. It's there, somewhere among those rings. . . .''

''I don't believe it,'' Jack said. ''There's no such thing.''

''Believe it,'' Brightbar said. ''They exist. Scarce as teeth on a Procyon duck, but they're out there.''

''I guess you've seen them!''

''I did,'' Brightbar told him. ''I used to hunt asteroids in the Near Arm with an oldtimer named Whipple. We shinnied around some of the nearby systems for years—Arcturus, Indi, Groombridge 34. . . . We were looking for the platinum group metals, like most of the space-diggers are nowadays. One time our hyperdrive cut out on us unexpectedly as we were heading back to 'Ceti with a year's work in cargo bay.'' Brightbar cracked his huge knuckles with a sound that made Tina jump. ''That can be dangerous, I guess you know. Your chances of popping out inside a star or something like that are very small, of course. But you stand a pretty good chance of coming out somewhere where nobody can help you, if you can't get your drive working on your own.

''We came out inside the remnants of a protosolar nebula. Planetesimals and asteroids and just plain rocks buzzing all around us like a swarm of bees. The program overload alarm on our navigational computer was blinking off and on like a strobe light. Well, we limped around it there on reaction drive, trying to get up above the disk plane. Then we saw it. A gas giant just in the final stages of collapsing in its share of the nebular soup, and already with a well-developed ring system.

''The gravity well of that thing was deflecting most of the rocks around it. It looked safer than dodging our way up above the ecliptic with an overloaded computer—it was only about a quarter A.U. from us. So we headed for it, gritting our teeth every time something slammed into the hull. We tried for a polar orbit that would take us through the outer fringe of the ring plane of that thing every few days. We made it okay, but in all the excitement somehow the X-ray unit got turned on by mistake.''

''X-ray unit?'' It was Tina, totally engrossed in the tale.

''X-ray fluorescence, ma'am,'' Brightbar said. ''Every rock-ship's got

one. For screening asteroids for valuable metals. It puts out a beam of hard X-rays. They excite the inner-shell electrons of anything they hit. When the electrons drop back to where they're supposed to be, they give off what they call secondary X-rays. Just certain energies, though. Each element has its own . . . fingerprint, you might say." He paused a moment to be sure she understood. Tina nodded. "Well, as I was saying, somehow this thing got turned on. Then, as we were making our first pass through the ring plane and I'm fighting with the controls, all of a sudden the oldtimer, Whipple, he starts yelling like he's having a spell. 'Gold!' he's yelling, 'We struck gold!' First, I thought the strain had been too much for him, so I locked the controls and hurried over to him. But sure enough, there it was on the dial—the strongest gold response I'd ever seen."

Brightbar looked around the table at his enraptured audience. "The ring we passed through on that first half-orbit was gold, all right—vapor deposited as the metal on the pebbles of ice and rock that made up the ring. Over the pole of the planet I altered our trajectory a little and we came down through iridium on our second encounter with the ring plane. I hit the thrusters again over the south pole and two days later we passed through rhenium." He looked at Jack, whose mouth had fallen open. "It's all there—platinum, osmium, rhodium, palladium, rare earths, uranium—all free of contaminants. Of course, there's the baser stuff too, that you wouldn't want to be bothered with—iron and cobalt and nickel and such . . ."

"But how . . ." Jack said. "What could have created rings like that?"

"I don't think anybody knows for sure yet," Brightbar told him. "Not many people know about glory rings. Like the lady said, most people think they're some kind of fairy tale. Scientists and university professors—they'd probably be able to figure it out, but they're not the kind that would put much stock in the word of an old space-digger like me."

Tina wanted the rest of the story. "How did you and Whipple get home?" she asked.

"The hyperdrive needed a new vanadium alloy widget for the damper on one of the primaries. We found the rings we needed, scooped up enough of the right metals and melted the alloy in a small assay furnace we had on board. We made up a mold and cast the part. It worked out just perfect. But if we hadn't stumbled into that system and found the glory rings, I probably wouldn't be sitting here talking to you."

"You must have brought back a fortune with you," Jack said.

Brightbar shrugged. "Not so as you'd look at me today. We never did go back and try to find that system again, though Whipple talked about it to his dying day. Me, I was content for a good long while with the money I made. Bought myself a big farm on a little world called Moonlight. Even . . . well, me and this little lady there were sort of friends . . ." The giant snorted. "Pardon," he said, "I got this god-awful sinus. . . . It didn't last too long, the farm and all, I mean. What with one thing and another, the money's been gone about ten years now."

Tina sensed a deep hurt in the Mendelkind—something so covered and hidden that not even he could look at it clearly any more. She wanted to say something to him, but couldn't find the words.

Dobson jumped in. "Perhaps now, Mr. Deiner, this proposed venture seems a little more plausible to you?"

Jack grinned. "Just a little," he said. "If this is for real and you propose to go out there and bring back treasure, I still can't believe that you're letting me . . . ah, Tina and me, in on it."

Dobson spread his palms. "Brightbar likes you . . . *I* like you. The time is short—there are only two suitable ships in this system right now and a ten-day retainer has already been placed on them. . . ."

"That's another thing," Jack said. "Who's financing this expedition? *We* don't have any money."

"I scraped together enough," Brightbar said. "I'm putting every last credit to my name into this. I don't care about shares and such. As far as I'm concerned, we split it even four ways. If we find the rings, there'll be more wealth than any of us can spend."

"You're not sure you can find that system again?"

"Nothing is sure," Brightbar told him. "Whipple, he held on to the flight recordings until he died. Willed them to me, he did. I've had them analyzed and checked them out myself. They're rough, lots of data drop-outs. Don't kid yourselves about this thing—it's dangerous."

Tina felt her heart beating. She was a child again, a teenager on Olive I. She looked at Jack and saw another man—the freighter pilot—smiling back at her.

"Well," he said, "what do you say?"

III

God, this is pretty country! Jack thought, standing at the ferryboat's deck railing. A herd of nauroch—hundreds of the shaggy-maned ungulates—had gathered at the river-edge to drink. Behind them, against a vast plain of grassland, Banjoqueen's type M sun was descending behind a line of snow-capped mountains. *I missed this kind of stuff, working in the mines, and never even knew I missed it. Now it's going to be—what? Cold steel bulkheads, machinery ticking all around. No worse than the mines, really. You forget about where you are, the danger.*

Tina was standing next to him, shielding her head with a newsfolder from the light sprinkling of rain. "Look at the baby in the water," she said. One of the nauroch calves had tumbled into the river and was struggling to rejoin its mewing mother on the bank.

This is crazy, Jack told himself. *This is the craziest thing I've ever done. I'm going to die out there in some place that doesn't even have a name. With three people I barely know. Better than alone . . . no—not Tina. She doesn't belong on something like this.* Jack looked over at her and watched her giggle as the calf scrambled awkwardly to safety.

"Tina, I was thinking . . ."

"Yes, Jack?"

"Nobody's bending your arm on this,

you know. Lot's of things could go wrong . . . I'd hate to be responsible . . .'' It was coming out all wrong. He took her by the shoulders, a river breeze fluttering the newsfolder that she still held aloft. ''We could all *die* out there. This isn't cut and dried like prospecting in the hills. And it isn't an adventure like flying off to Amadine or London.''

''I know that, Jack.''

The ferryboat captain had waited until the deck passengers had all gotten a good look at the nauroch herd. Now he blew a thundering blast from a steam whistle and the startled animals raced like a massive black cloud toward the sunset.

Tina's attention was caught by the show.

''I wonder if you do,'' Jack said, looking at her with a serious expression.

Dobson appeared out of nowhere, sporting a new-looking beaked cap and broad grin. ''Well,'' he said, ''I see that you two found a warm spring shower a bit more appealing than the confines of a steerage compartment.''

Jack let his hands drop from Tina's shoulders. ''The air conditioning seems to be out all over this tub. Did you see the buffalo?''

Dobson strained his eyes toward the diminishing cloud that was the nauroch herd. ''Just missed them, I'm afraid. Magnificent creatures. Rather good eating too, for those with the means to afford steak.''

Jack regarded the man with a little distaste. *Strange bird, if there ever was one. Talks with that affected air. Skinny as a rail, with a perpetual five-o'clock shadow. Obviously, he's got some kind of shady background. I wouldn't turn my back on him.*

''The captain informs me that we'll be making Kimberlite by midnight,'' Dobson was saying. ''The shuttles leave every 90 minutes all night long, so that I don't imagine we'll have too long a wait at the spaceport terminal. It's my understanding that Brightbar has arranged accommodations for all of us on the Port-Wheel.''

Tina looked excited. ''Both ships are docked there, then?''

Dobson nodded. ''So I'm told. A caravel and a reconverted light ore freighter. Both consigned to us for one trip of indefinite duration. We'll be able to spend several days familiarizing ourselves with their operation before departure.''

Jack rubbed his chin. ''Say, Dobson. I've been wondering . . . Just how much experience do you have with this sort of thing?''

''You mean piloting a spacecraft?''

''Space-digging, prospecting in general—the whole works.''

Dobson adjusted the beak of his cap and grinned. ''Why, none at all.''

Inside Jack something deep and heavy sank deeper.

''The operation of these craft is child's play, Mr. Deiner. Everything is automated. As to the operations required when we reach our destination —we have Brightbar's prodigious experience to rely upon.'' Dobson was beaming, almost like an actor playing a part. ''I, for one, have no reservations about this venture.''

Jack made a sour face and looked away. ''Then you're a fool,'' he said.

Dobson blinked, still grinning. ''Per-

haps, Mr. Deiner. Perhaps. Good fortune has been a fickle mistress to me in the past. And yet an inner voice is telling me that she won't elude me this time. In some inexplicable way I'm convinced that the Fates are smiling on our enterprise. In a sense, I believe the Universe owes me this one."

Jack watched the last smudges of pink above the distant mountains. "They used to say, back on Deephole, that when you start hearing voices it's time to pack up your gear and head back into town."

Dobson turned to Tina. "And you, Miss Petulack, do you believe in Fate, Destiny—call it what you will? The Hand of God in the affairs of men?"

Tina smiled, uncertain how to respond. "Sure . . . Well, if Jack hadn't lost that money . . ."

"Precisely," Dobson said. "The Fates have brought the four of us together. Each of us—you will forgive me if I am somewhat blunt—each of us destitute and despondent to some degree. Each of us, as a result, responsive to an audacious scheme to reverse our fortunes. . . ."

"Brightbar wouldn't have had to look very far to find three other people in Sugarville with our qualifications," Jack said. "How did *you* meet him?"

"Quite as you two did," Dobson told him. "Three days earlier in the Yellowcake Saloon, and at the very same table where our plans were forged. We struck up a conversation wherein he admitted to a passion for the Bard . . ."

"The bard?"

"Shakespeare. Quite a rare taste among the denizens of the Yellowcake, I'm sure you can imagine. We spent a most pleasant afternoon quoting soliloquies to each other. Remarkably, Brightbar's knowledge of the plays is formidable. Never judge a book by its cover and all that. Still, I must confess, I wouldn't have expected to hear *Hamlet* from a . . ." Dobson caught himself in mid-sentence, the smile evaporating.

There was an awkward silence, then it was Jack's turn to smile. "Prospector, Dobson? Is that what you were going to say? Or did you mean, Mendelkind?"

". . . from a man of Brightbar's background . . . ah, actually was my point, Mr. Deiner." The toothy grin reappeared. "We're *all* prospectors now, of course. Or soon will be. . . ."

A line of dark trees on the riverbank was inching by the deck railing. The light pattering of rain made a hissing noise on the leaves that carried over the water.

"I don't know Brightbar any better than I know you, Dobson," Jack said. "But I believe that if we get out of this with our skins, it's going to be mostly because of that Mendelkind."

"A point well taken, Mr. Deiner. I couldn't agree with you more." Dobson peered up at the starless sky. "The air seems to have taken on a bit of a chill," he said. "I believe I'll retire to my cabin." He touched the beak of his cap and nodded to each of them. "Miss Petulack, Mr. Deiner. I'll see you when we debark."

When they were alone, Jack turned to Tina. "That guy is trouble," he said in the conspiratorial darkness that had descended on the passenger deck.

"Mr. Dobson?" Tina said, almost in a whisper. "Oh, I don't think so, Jack. Maybe he's a little strange. . . ."

"There's strange and then there's strange . . ." Jack looked out toward the dark hissing trees. "I've got a feeling about that guy," he said. "And it doesn't feel good."

The official Port of Entry for the world of Banjoqueen was an ancient steel donut with a kilometer-sized hole. Its old-fashioned geosynchronous orbit harkened back to a day when the fuel to lift shuttles out of a gravity well was cheap and plentiful so that the world-sweeping polar orbits of its descendants at more recently settled colonies had been considered too wasteful. Too wasteful of the precious time of frontier-types and mining entrepreneurs, anxious to be on their way toward planetside, or outbound to other worlds.

The Port-Wheel pastry was pebbled with an evanescent crumb-topping of freighters and ore ships, frigates and passenger liners, with a finer texture composed of the shuttles and private launches that streamed up and down from the seven major planetside spaceports.

Jack stood at the viewport of their cabin, one of hundreds along a portion of the hub. Banjoqueen was a green-and-white-mottled disk, partially obscured by the rusted flanks of a parked fuel-tanker.

"Beautiful, isn't she?" Tina said behind him, dressing in the small bathroom.

"They're all pretty," Jack said.

"When you've lived some place, I mean—for most of your life . . . or for a long while anyway . . ." Tina emerged, smelling of soap, and stood behind him at the window. "To see it then, from up above like this . . . cool and green with no sign that there's anybody living there . . . Doesn't it just take your breath away?"

"Yeah," Jack said, but his mind was elsewhere and when he turned around there was a serious look on his face.

Tina caught his mood. "What's wrong, Jack?" she said. "Are you still worried about Mr. Dobson?"

"Something I started to say to you back on the ferryboat . . . I *like* you, Tina. Maybe I . . . well, I like you a lot . . ."

She squeezed him with an affectionate hug. "I like you, too, Jack. A *whole* lot." She tried to suppress a giggle and failed miserably.

He held her away from him and looked into her eyes. "*Because* I like you a lot, I want you to catch one of the morning shuttles back down to the Kimberlite spaceport." She started to say something, but he continued over her words: "I've been thinking about this ever since we left Sugarville. The whole plan is crazy. . . . Glory rings! It's a wild goose chase at the very best! We don't know these guys. Dobson is crazy with something nasty underneath. And Brightbar is just plain crazy."

Tina's lips were trembling, but she managed to smile. "I *want* to go, Jack," she said.

Christ, what have I got here! Jack thought. The time for kind words was past. "You want to go because I'm going! Well, forget it! I don't need a nursemaid. Jack Deiner works alone."

The tears he expected from her didn't come. "Okay, Jack, you've got your reasons for going, but don't presume you know mine." She stepped out of

his grasp and squared her shoulders. "You're not my nursemaid either, Jack. I'm going on this trip for the same reason you are. The money, the adventure—sure, to some extent—even if the odds are ridiculous against us. But the deep-down reason for both of us is that we don't have anything left to lose."

Jack was genuinely surprised by the show of strength, but he still didn't believe a word of it. "Eyes open, baby—this is a dangerous game you want to play."

"My eyes are open," Tina said. "You've got no strings on you."

It wasn't working right at all. Jack felt a twisting in his stomach. "Look. Tina . . ." There was a chime from the doorbell.

"That's Brightbar," Tina told him. Then she walked with amazing calm to the door and snapped the release.

The Mendelkind had to stoop to enter their cabin. He was dressed in a light blue robe sashed at the waist and looked rather like a gargantuan monk. " 'Morning, folks," he said. "All set to look over your ship?"

Jack nodded without enthusiasm.

"What's her name?" Tina asked.

"Good name," Brightbar said with a smile. "The *High Sierra*. It's a good ship, too—I've been out in her a couple of times. Oh, and I've got something for you, Jack . . ." He reached into the massive folds of his robe and produced a sheaf of papers with a magnetic coding stripe across the top of each one.

Jack took the papers with a furrowed brow. They looked like some kind of legal document. "What's this?"

"Your pilot's license," Brightbar told him. "It says there that you've had five years of experience with *ster-vos* class caravels. Documents all your flight time. It even includes an incident where you were cited for unauthorized use of your hyperdrive less than two AU from a populated world."

Jack was flipping through the stapled pages. It certainly *looked* authentic. And there was his name in several places. Correct date of birth. Even his merchant marine service.

"All the signatures and seals are there," Brightbar said. "I've got a friend who has a friend. The friend owed me some favors."

"Now all I have to do is be able to fly the thing," Jack said, folding the sheaf and tucking it in his back pocket.

"That's what I'm here for—let's get going."

Tina and Jack followed Brightbar out into the passageway without another word. Trailing slightly behind the huge strides of the Mendelkind, they avoided each other's eyes.

A series of ever more rapidly moving pedestrian-belts carried them to a high-speed elevator. When the mirror-like doors slid open, they stepped out into a large echoing area with steel-riveted walls.

"Mooring Sector L," Brightbar explained. "This is where all the leased freighters are docked."

Immediately, they were on another moving belt carrying them past a widely spaced row of closed hatches and cargo-doors.

They stepped off the belt at Brightbar's cue and followed him up to one of the airlocks. A small changeable placard hung on the steel wall next to

the hatch: "*High Sierra*/Registry: Landholt Mines, Ltd."

"A defunct mining operation out of 'Ceti owns the ship," Brightbar explained. "What's left of the company has become a leasing agent for their old equipment."

"Just how *old* is it?" Jack asked as Brightbar cycled them through the lock with a magnetic passkey.

"She was built in the Neuholland yards about twenty standard years back. That's not what you call old for a *ster-vos* class. Those Dutchmen know how to put a ship together."

"*Ster-vos?*" Tina asked.

"Star-fox, Ma'am. She's smart like one, too. Wait'll I show you the flight computer."

The interior lights had flicked on automatically as the inner hatch sprang open. A passageway of restful green stretched out before them. "Walls and ceilings are lined with deep-pile carpeting," Brightbar told them. "Nice touch that is—saves you some bruises if your gravity generators should cut out on you."

They followed Brightbar down the cushiony rug, Tina pausing once to squeeze a handful of the wall.

"Up here's the control room, such as it is." Brightbar unlocked a metal door that looked amazingly like wood.

The control room was smaller than Tina's apartment. Two padded swivel-chairs faced a long panel of lights. A low table with a recessed food locker was bolted in place between the chairs. Three meter-sized viewscreens were mounted on the wall. Everything else was green carpeting.

"Those panels back there pull down into beds," Brightbar told them, indicating a back wall.

"You mean this is it?" Jack had expected more living room.

Brightbar shrugged—a massive gesture in the little room. "A ship like this is strictly business. There's a quarter-million cubic feet of cargo bay behind us and a hyperdrive engine the size of half a city block. Not much room left for any fine points or niceties. The john's back of here, by the way," he said, patting another part of the green wall.

Tina tried out one of the swivel chairs. "Ooh! This is comfortable!"

"You spend plenty of time in them," Brightbar explained. "Now I want you both to meet someone. . . ." He stepped up to the panel of lights and flipped a series of switches. A few lights began flickering in greens and yellows.

"*Listo,*" a voice said from a hidden speaker.

Brightbar chuckled. "Darn bootstrap loader always puts it back into Spanish." He flipped two more switches on the panel.

"Begin," the voice said.

"Uh, load modules seven, nine, and ten," the Mendelkind said.

A few more flickering lights came on. There was a brief pause while the lights danced, then: "Good morning, friends. My name is ESTEBAN."

"Is that a Spanish accent?" Tina asked.

"Just a trace, I guess," Brightbar said. "Programmers are a funny lot sometimes. The ship being called *High Sierra* and all—I guess they thought it was a nice touch. I imagine we could

eliminate it easy enough if it bothers you.''

''Oh, no,'' Tina said. ''I think it's really neat.''

''This is a really sophisticated program,'' the Mendelkind said, leaning an arm on the panel. ''One of the best I've ever seen. It's the real reason why I'm not worried about you two.''

Jack's mood had become blacker, as he realized how dependent their lives were going to be on that accented voice. ''How do you talk to it?'' he asked.

''It recognizes any sentence that begins with its name as needing some kind of response,'' Brightbar told him. ''Esteban: this is Jack Deiner and Tina Petulack—tell them all about the ship.''

IV

Five days later, the two ships were underway.

Tina was nibbling at a food concentrate bar, as she studied their sister ship on one of the viewscreens. Against the star field it looked old and dark, with floodlights illuminating hyperboloid patches at random intervals along its four dirigible-shaped bays. In one patch of light, white letters—each twice as high as a man, she knew—stood out from the dull metal hull: *Ganso d'Oro*.

Golden Goose, Brightbar had told her. *He goes a lot by names, he said. He wouldn't fly in a ship if he didn't feel right about the name. Prospectors are superstitious. Nothing odd about that, I guess—their lives are built around luck.*

Tina took another bite of the sweet bar and chewed reflectively. *Jack. A giant. A goose that lays golden eggs. Well, a golden goose, anyway.* She pushed the thought back into a corner of childhood memories. She looked over toward Jack in the other chair. He was studying a three-dimensional plot on another of the viewscreens: a series of funnel-like wells in a checkerboard grid—the planetary bodies in the outer orbits of Banjoqueen's system. A piece of black hair had fallen down into his eyes and he brushed it back without removing his gaze from the white dot that marked the position of the two ships.

He's a good man, Tina thought. *And there's a hurt in him. I saw it in Brightbar, too. Life's hurt them both. Dobson, too. And me. Each of us deals with it in our own ways. Jack, though, he thinks he's long since formed all the appropriate callouses. . . .*

''*Ganso,* this is *Sierra,*'' Jack said. ''I read two-oh-oh seconds to jump.''

Brightbar's voice came back from the speaker almost immediately: ''This is *Ganso, Sierra*. I read one-eight-oh seconds on my mark. Mark. How are you folks doing, by the way?''

''Just fine,'' Tina said, but she had forgotten to toggle her chair phone.

''How's that?'' Brightbar asked.

''We're doing fine,'' Jack answered for her. ''Our navigational program is slaved to your operating system's supervisor by tight Y-band.''

''That'll switch automatically to phase modulated tachyon beam once we jump,'' Brightbar told him. ''Never mind the terminology—but don't forget to make that parity check once we're in whitespace.''

''I got you,'' Jack said.

Tina looked up again at the immense

dark ship on the screen just as it eclipsed a particularly bright star. She caught herself just as she was about to take another bite of the concentrate bar. *I always eat when I'm nervous,* she thought, putting the remnant in a pocket of her coverall. *Well, this is it. I'm not really scared, like I thought I would be. Just sort of tense and tingly.*

"Good luck, folks," Brightbar said from the speaker.

On the screen there was just a moment when the eclipsed star reappeared, shining brightly through the hull of the *Ganso d'Oro*. Then the screen, like an inverted lapse-dissolve, faded into white.

"What are you going to do with all that money?" Tina had been looking over Jack's shoulder as he studied the transcript of the flight recordings that the old prospector, Whipple, had willed to Brightbar. Esteban had put the text up on one of the viewscreens and right now a page was showing that recounted the haul that Whipple and Brightbar had brought back with them.

"How's that?"

"The money. All those riches we're supposedly going to bring back from the glory rings. How are you going to spend it?"

"I'm going to get myself a villa on 'Ceti," Jack said without hesitation. "On the bay, north of Point Hope. I've seen that once—it's real pretty up there. Brown sand, like talcum between your toes. When that sun goes down over the ocean, it's quite a sight."

"It sounds beautiful."

"Esteban: show the lady what I mean. Ah, *Galactic Atlas,* tau Ceti system, 'Ceti, northern hemisphere, Pineridge landmass, northwest coast, Powder Bay at dusk."

"Jeest a moment, Jack." The program was riffling through its archival storage files. "I know I haf it here, somewhere."

In another moment what might have been a travel poster scene appeared on the viewscreen: waves lapping at a cocoa-colored beach, cycadaceous trees in silhouette in the foreground, a red sun staining the watery horizon.

"That your idea of paradise, huh?" Tina smirked playfully.

"It'll do for now. What's wrong with it?"

"I thought you'd be more the type to go for a cliff palace on Amadine, complete with a harem or two. Or maybe an apartment in London overlooking Central Park."

Jack laughed. "I think you got that last one wrong somehow."

"Okay," Tina said. "A villa on 'Ceti. What else, then? Don't forget, you're going to be fabulously wealthy."

Again, Jack didn't hesitate. "A bar, I think, a really classy place. I've spent a lot of time in run-down saloons. I'd like to have a high-class bar someplace."

Tina sat down on the green rug and rested her chin on her knees. "How about buying out the Yellowcake? Put it back to what it once was?"

Jack swivelled his chair to face her. "Sure, why not? Maybe a chain of places like that on different worlds."

Tina could see that Jack was really getting into this. "What else?"

"A couple of interstellar yachts, complete with crews—just for traveling around when I felt like it. Maybe a sum-

mer house on Debbie III—they've got some nice wooded mountains there. A few dozen hovercars and flivvers every place I stayed, of course . . ." Jack stopped and grinned. He must have realized that he sounded ridiculous. "To quote you, baby: Now it's your turn . . ."

Tina rubbed her chin on her knee. "Money's never been too much of a thing with me," she said.

"Not fair!" Jack said, wrinkling his face in an imitation of Tina.

Tina exploded with laughter. She stretched her legs out and braced herself with her hands, still shaking with giggles. "Did I really sound like that to you?"

Jack kept up the parody. "I told you mine," he said. "Now you tell me yours!"

"*Sierra,* this is *Ganso.*" It was Dobson's voice. An unwanted intrusion that broke the mood.

Jack snapped the communicator switch. "*Sierra,* here," he said.

"Brightbar informs me that we are drifting too far apart. Something to do with gravitational effects on the computer link between us. He indicates that if we don't make some manner of correction now, we'll be nearly thirty AU apart when we emerge in normal space. It seems that will be rather a bad situation in the protosolar cloud with all that clutter around."

"Let me talk to Brightbar."

"He's busy right now reprogramming our computer," Dobson told him. "He says he wants you to instruct your computer to . . . ah, clear module four and set up to receive a data dump from us."

Tina got up from the floor and took her seat in the other chair. "Is this serious, Jack?" she asked.

"Yes, I think so," he said. "The distance between our two ships should normally be automatically corrected over the data link." In a controlled voice he gave the required instructions to Esteban.

Tina could feel her pulse rising. "What could happen? I mean if Brightbar can't fix it?"

Jack ran his fingers through his hair. "It means we'll be on our own in normal space. Thirty AU is much too far for any kind of real-time data link. Even one AU is too far. At thirty, our voice channel will have a twenty-second delay. That'd be something like four hours if we couldn't use the tachyon beam for some reason."

"Can't Esteban handle it alone?"

Frustration was building on Jack's face. "Supposedly. I don't know enough about these things to be able to say for sure. For one thing, we'll have to break the data link before we jump back into normal space or the scrambled information that Esteban will be getting from the *Ganso* will kill us for certain."

"Please pardon, Jack." It was Esteban. "I haf received module four dump, but parity check failed."

Tina swallowed. She knew what that meant. The data dump had gotten scrambled in transmission.

Jack stabbed at the communicator switch. "*Ganso,* parity check failed. I'll clear the module and reset so that you can retransmit."

"*Sierra,* this is Brightbar. Your voicelink . . . breaking up. Must be some kind . . . ional anomaly. This . . .

appens sometimes . . .'' There was a buzz from the speaker, then: ''. . . point in trying again under these conditions. We've got ten standard days to try to . . . gure this thing out. Though I'd . . . to see it licked before we . . . too much further apart. Don't panic. Esteban is a real good . . . gram. If it comes to that, though, you've got to cut the PMTB before you jump to black . . . Say if you understand. . . .''

Jack's hand shook a little as he hit the communicator switch. ''Understood. Cut phase modulated tachyon beam before return to normal space.''

''*Sierra*. Jack; remember—not now . . . still a chance . . . clear up. We'll keep in touch . . . as voicelink holds out . . . Drift won't . . . any worse than it is now . . . If worst should . . . to worst . . . we'll rendezvous at . . . preprogrammed jump point . . . Keep calm and God ble—'' Another loud buzz from the speaker, followed by silence.

''*Ganso,* this is *Sierra*. Do you read?'' Jack waited for several seconds, then tried again. Only the leathery crunch of his chair's padding stirred the quiet.

Tina looked at his lined face, the mop of hair back down on his forehead. She could hear her own heart pounding in her ears, but her fear was somehow compartmentalized—in another part of her. Her thoughts were of Jack and how she wished him his dream.

''That's it,'' Jack said, still staring at the communicator switch. ''We're on our own.''

''Maybe the voicelink will come back,'' Tina said, trying to erase that look of blank despair on Jack's face.

''Maybe.''

''From everything that Brightbar told us, Esteban is fully capable of handling the ship.''

Jack looked at her, the hair in his eyes, and not bothering to brush it back. ''Some of that must have been for our benefit. Why would he want our flight control system slaved to his? Things can go wrong—every experienced pilot knows it. There's never been a complete substitute for a man at the helm— somebody who knows what they're doing. And the way he described the glory ring system—with all that junk whizzing around—it sounds like he expected he might have to fly both our ships from his.''

''Still,'' Tina said, ''Brightbar didn't sound worried. . . .''

''Why should *he* worry! He's a damn experienced pilot! I'm just a jerk who let himself get talked into this flight of fancy!'' The anger passed and Jack slumped down in his seat. ''Christ, Tina, I *told* you to catch that shuttle back down to Kimberlite.''

''We'll be all right, Jack.''

''Esteban,'' Jack said in a low voice, ''what is the ship's status?''

''All systems functioning normally, Jack. Do you wish a rundown of the operating parameters?''

''No, thanks.'' It was almost inaudible, as Jack seemed to sink deeper into dark thoughts.

''Jack?'' It was the computer's voice.

''I said, no, thanks, Esteban.''

''I heard you, Jack.'' There was a human-like hesitation in the voice. ''I just want you to know . . . I haf studied the tapes of the Wheeple and Brightbar journey very well . . .'' An animated

graphic appeared on the viewscreen in front of Jack.

Jack looked up at the display. It showed a segment of cottony gas with several comet-like streamers radiating away from it.

"What's that?"

"The Gum Nebula, Jack—the edge of it." The display zoomed in until the screen was filled by one of the streamers. "These haf been called cometary globules," Esteban explained. "They point away from the center of the nebula like weathervanes. The nebula was formed by a supernova explosion and these globular streamers were blown out in the shock wave . . . meellions of years ago, of course." The display zoomed in further until only the upper edge of one of the streamers was shown. A small white square with a tiny dot in its center appeared on the screen.

"Is that where we're going, Esteban?" Tina asked the question for both of them.

"Yes. The flight record of the Wheeple/Brightbar journey analyzes to this location." A larger square appeared outside the perimeter of the small one. "No other star falls within the two-seegma variance of the analysis." The display zoomed once again, until the square filled the screen. The tiny white dot grew steadily, gradually taking on an elliptical shape. A diffuse flattened disk resolved from the image on the screen. Then Esteban's imaginary camera penetrated the edge of the disk.

Tina was transfixed by the display. Through layers of dark gas, the dim spark of a young sun grew toward them. Boulders and planets, appearing suddenly, filled the screen for an instant, then rushed by, out of view. Sun-grazing comets flashed their tails at them. Now the gas cleared a bit, the infant sun glared at them from the center of the screen. Cold gas giants—massive dim worlds—rolled by in the distance, as the rock and ice debris continued to pelt at the screen.

Esteban snapped off the display abruptly and replaced it with an orbital schematic. "The flight record shows data for forty percent of all bodies more massive than ten to the fifteenth power kilograms and good estimates for the remaining sixty percent." The schematic showed hundreds of orbits, most of them overlapping with four or five others, but clearly, over the eons, the large had been gobbling the small. Rocky worlds occupied a maze of orbits closest to the protostar where the rain of mineral chunks had been the thickest. Four gas giants glided through the thinning fog of hydrogen and helium and assorted molecular gases a bit farther out, though a few more rocky worlds crossed their paths. Far outside this inner realm, in a titanic region of soupy gas, heavy comets orbited—some on wild, erratic paths that carried them steeply sunward.

Jack's brows knitted as he watched the crazy clockwork of the animated display. "Esteban?"

"Yes, Jack?"

"What's your point?"

"My point, Jack?"

"In showing us this now, I mean?"

There was, again, that slight hesitation. Like a man seeking the right words in a delicate conversation. "I just wanted you to know that I know my job. The system is difficult, yes, but not some-

thing I cannot handle. When we jump in there I will send out probes immediately in all directions. They will radio back information to fill the gaps in the Wheeple/Brightbar flight record. My onboard scanners will complete the picture. I can navigate for you in there, I haf no doubt."

Jack almost smiled. "You're trying to cheer us up?"

"Yes, Jack."

Tina looked down at Jack, then back up to the whirling display. "Oh, Esteban," she said, "that's really sweet of you!"

"Thank you, Meez Tina." The display snapped off—the screen was blank.

They sat for a few moments in silence, the image of that intricate clockwork racing in their minds.

Tina spoke first: "Did you know, Jack? What it's going to be like in that system?"

"I had an idea." His face was blank.

Tina bit her lip. "Esteban can handle it."

"So he says."

Tina stood up again and walked around to his chair. "There's always the chance that this . . . anomaly that's breaking up our signal will clear up, you know," she said.

Jack looked up at her standing beside him. "And what if it comes back," he said, "just as we're about to jump, say? Christ, Tina, I don't know about these things, but I'm feeling now like we ought to take our chances with Esteban."

"How long until we jump back to normal space?"

Jack patted the smooth metal of the light panel. "Esteban: answer the lady."

"Two hundred and thirty-six standard hours, Meez Tina."

Jack slouched in the chair. "The way I figure it, if we don't have solid and steady contact with the *Ganso* in half that time, we should go with Esteban, regardless. What d'you say?"

Tina smiled at him. "You're the captain."

"Yesterday I was a dumb, penniless, out-of-work miner. Today, I'm the captain of a *ster-vos*-class caravel!" Jack was fighting it, but cracked a smile anyway. "Okay! That's what the captain says we do . . . unless Brightbar gets through and tells me I'm all wet."

On an impulse, Tina slipped into his lap. "Aye-aye, sir," she said.

Jack kissed her warmly. *I hope I'm not too heavy for him,* Tina thought, enjoying the comfortable closeness. Moments later, she saw him look down at his shirt.

The half-eaten food concentrate bar in Tina's lapel pocket had smeared out between them. Jack dipped a finger in the mess and tasted it. "Mmm," he said. "Tell me, miss, what other flavors . . . ?"

She swatted him, giggling, and they kissed again.

Hours passed. As they lay together on the small cot in the darkened control room, Tina propped herself up on one elbow. "Jack, I was wondering . . . just how . . . realistic was that simulation that Esteban showed us?"

Ten days later, they knew.

V

In the old days, when man first

stepped from the cradle of the Earth, he measured distance in "astronomical units." Like the distance that a fast runner could travel in a day, the AU served to map off a dominion in units from which the mind didn't reel. Like many things—unlike most things—it became a convention of scale that survived the time when it was the largest graspable unit in which a man could measure his journey.

Imagine, then, a cloud of dust and gas in a great disk, two thousand AU across. That is what it is—most of it—dust grains no larger than a wavelength of visible light and thin, cold gas. Only deep inside this ovaloid of thin soup, deep inside, interesting things are happening.

Halfway in, at mid-radius, clouds of comet clusters orbit the denser mass within. From here the cloud thickens dramatically—an inner disk spinning with slow grace. Much farther in, deep within the inner disk, dust grains collide, adhere, gathering mass. Gravity draws them into a thin spinning sheet at the core of the disk. Farther in, and the falling grains are a steady rain; farther still and they are a raging torrent. The thin sheet is a core of mass now. It has an existence of its own.

The grains now collide within the sheet. Some stick, some bounce, many shatter. Clearly, though, a trend has appeared. Globules of mass accumulate, as the large sweep up and collect the small.

The process goes on, the masses build. Planet-sized masses are squeezed into solidity as clusters of boulders agglomerate and fuse. The gases themselves are gravitationally drawn to some of these planets, condensing onto their surfaces in titanic volumes.

This was the after-show to the formation of a star—the yellow furnace at the disk's hub. A minor footnote on the cosmic page. An epilogue.

Now it, too, is nearly written.

"Program alarm!"

Tina had been studying the particular tiny light on the panel in front of her since before they jumped to black. Now it blinked redly: once, twice.

Jack glanced over. "That's okay," he said, his voice tense. "Just a temporary data overload." His eyes moved back to the viewscreen above him: another three-dimensional mass map that showed a slice of the space around them. This time the grid was puckered like an ornate bas-relief carving. Funnels and holes surrounded the tiny white dot that was the *High Sierra*; many of them were visibly moving.

"Esteban: do you have a radar fix on the rendezvous point?" Jack wiped sweat away from his eyes.

"Yes, Jack," the calm voice told him. "From probe seven. I haf video, if you would care to . . ."

"Put it on. Screen B. How about the *Ganso*?"

"I thought I had something a moment ago, but it analyzed out as reflections from some oddly shaped asteroids." The second screen flickered, flashed, went blank again.

"What's wrong?" This from Tina, fingers gripping the armrest of her chair.

"Probe seven . . ." There was a noticeable lurch, as the ship's inertia-field overloaded from a sudden high-G maneuver. "Probe seven is transmitting an erratic signal," Esteban told them.

Tina checked her seat belt for the hundredth time. The little red light had winked once more.

"How about the other probes?" Jack licked his lips.

Silence. They stole a glance at each other.

"Esteban!"

"Sorry, Jack. I was busy. Probes five and nine are out. They were probably hit by something. Seven is putting out a signal without synch-lock. I am sorting the pixel stream, but it is slow and low priority right now, I am afraid. The other nine probes seem to be okay."

Something hit the side of the ship, hard. The sound was like a struck gong somewhere far below them.

"The cargo bay," Jack said. "Hull integrity light still shows we're tight."

Tina let out caught breath in a sigh.

"We have to take some leettle ones to avoid some of the big ones," Esteban explained, almost apologetically.

The A Screen now was marked with an "X" on the rim of an enormous funnel that had crawled into view at the upper left. It was the rendezvous point, Jack realized—the glory-ringed planet. The white dot that marked the *High Sierra*'s position was being tracked at mid-screen. If they made it, the "X" would appear to come to them.

"What's our distance, Esteban?"

"Estimating the heading and the expected course and speed changes . . . it will be about a standard hour yet, Jack."

Jack tried to slouch, but the seat belt held him. *Relax,* he told himself, *we're either going to make it, or we're . . .* His eyes riveted to the screen. A deep, narrow mass-hole had appeared at the top of the display and was moving rapidly on a path that would intercept them.

"Esteban!" But the engines were already firing with a burst of acceleration that lit several warning lights in front of him.

But the white dot on the screen remained in the streaking funnel's path!

Jack checked the light panel again. Something like panic must have shown on his face. "What's wrong?" Tina said.

The planetesimal was closing rapidly on them.

"Esteban!" It came like a hoarse croak.

The speeding mass was almost upon the white dot. There was no way they could escape collision now—even with the big reaction drive engines of the *High Sierra*.

This is it, Jack thought. *It'll be over in an instant. God, I hope I'm right about that! My fault Tina's here. I handled it all wrong.*

Tina knew now what was happening. She'd seen the deadly funnel sweeping toward them. "I love you, Jack," she said, her hand stretching toward him across the table that separated their chairs.

Jack stretched out and took her hand. It was cold and wet and it held him with amazing strength. He forced himself to smile and winked at her. "Boy, you sure pick 'em, don't you, kid?"

There was a moment that they held hands in silence, knowing they were dead. Braced and tense and ready—almost, in that instant, content. The moment passed.

Jack looked up at the screen. The speeding funnel-shape had *passed* the

white dot that marked their position. Jack blinked, his hand still held in Tina's grasp. How could it be?

"Esteban?"

"Yes, Jack?"

The planetesimal or whatever it had been was speeding away from them now, moving toward the lower edge of the screen. It had passed through them. Or what else could have explained the mass-simulation on the screen?

Jack had been about to frame a question for the computer, when his eye caught something on the panel. Three acceleration lights had just winked out, a fourth was flickering and now it, too, died.

"Esteban," Jack said, "did you just move us at high acceleration up above the ecliptic?"

"Yes," Esteban told him, "it was a high-thrust burn, but I trust you didn't feel it. I monitored the inertia-field and . . ."

"Then, that large mass . . ." Tina said, "it passed *under* us?"

"In a manner of speaking, Meez Tina, yes. I am sorry if the display caused you any alarm. There wasn't time to update the simulation. I will correct it now. . . ."

Jack felt Tina's fingers slip away from his. There was a second when he knew himself to be a fool. A *real* pilot of a ship like this would have known exactly what had been happening. The embarrassment was quickly replaced by anger. He felt the blood rush to his face. "Why didn't you tell us what you were doing!"

"I was busy, Jack," Esteban replied, in the same calm voice. "This vocal response subroutine is very slow and, I am sorry to say, must be low priority in the interrupt table."

Anger and embarrassment warred in Jack's mind. Embarrassment won out. *Of course,* the voice communication was low priority. The lights on the panel were telling him everything that an experienced pilot would have needed to know. *How do you apologize to a piece of software?* he thought. *You don't.*

But, anyway, he mumbled, "Sorry, Esteban."

The minutes stretched out like hours, as every winking light on the panel riveted their attention, every clang on the hull brought a fresh surge of adrenalin. Slowly, the "X" of the rendezvous point and the great funnel of the glory-ringed planet crawled toward the white dot in the center of the display.

"Do you have a picture from probe seven yet, Esteban?" This from Tina. She'd spent the last several minutes watching an outside view from the onboard cameras on Screen C. The immediacy of that perspective—with pitted rocks appearing suddenly, and the rapid blur as Esteban accelerated them away from danger—had frightened her, and Jack had ordered Esteban to take it off.

"Not yet, Meez Tina."

"How about the *Ganso*?" Jack asked.

"Nothing yet, Jack. I haf been signalling when I haf the time, but you might try a voice channel."

Again, his inexperience had been obvious. Jack punched the communicator switch. "*Ganso,* this is *Sierra*. Do you read?"

A crackle, then silence.

"*Ganso*, this is *Sierra*. Say your status if you read."

There was a blurred something that sounded like a voice.

Tina leaned forward, straining to hear. "Jack, I think that was Brightbar! They must be all right."

Jack asked Esteban for their present coordinates and passed them along on the voice channel. He was rewarded only with another crackle from the speaker.

"Esteban: was that a contact that we heard before?"

Jack had to wait for an answer as three clangs rang against the hull.

The hull integrity light switched from green to red. A high-pitched alarm sounded.

"We haf damage to cargo bay four," Esteban told them. "I haf tried to seal hatches to that area, but we are losing pressure. The control room is secure. Do not be frightened."

Jack felt his heart pounding as he snapped a switch that cut off the alarm. "Esteban, how bad is it?"

Another clang ran through the ship. The program alarm light winked several times.

"Esteban!"

"Jack, you and Tina must put on the pressure suits which are secured in the wall panel behind you. Cargo bay four adjoins the control circuit duct for the hyperdrive engines. The crystal relays in there must be protected from the cold and vacuum." Esteban put a ship's diagram up on the screen. "All hatches haf sealed except this one here." A pulsing circle marked the spot on the screen. "You must go down there and secure that hatch."

Jack had his seat belt open and was moving toward the suits.

"Something must have wedged in the door seal there that was missed at inspection," Esteban said in the same softly accented calm. "I am sorry to haf to ask this, but there is real danger and it is not something I can do myself."

Jack and Tina were almost in their suits. Brightbar had drilled the procedures into them while they had been docked at the Port-Wheel.

Jack felt his hands shake as he checked Tina's suit, then his own.

He saw Tina's lips trembling through her faceplate. "You stay here, Tina," he said. "I can handle this alone."

"No, Jack, I . . ."

"Now look. You're only going to be in the way down there. I've been through this kind of thing in the merchant marine." He tried to make his voice sound hard and it came out even rougher on the radio circuit of their suits. "No arguments this time! Sit down and strap in! I'll be back soon."

He turned and keyed open the control room hatch. The simulated wood panel slid back and there was an outward hiss of air. The incongruous green carpeting stretched out before him. As he closed the hatch behind him, Tina was still standing beside her chair. " 'Luck, Jack," he heard in his earphones.

It had been a long time since he'd walked in a pressure suit under ship's gravity. His steps were clumsy, almost a stagger, down the carpeted corridor.

The hatch to cargo bay four was in the ceiling. On the wall he found the appropriate switch and the panel slid back and a metal-runged ladder descended. It was a slow climb into dark-

ness. At the top of the ladder he found the light switch. The passageway was narrow and made of dark, riveted metal. A steady hissing sound told him that the problem hatch was somewhere not far ahead.

"How are you, Jack?" Tina's voice, trying not to sound frightened.

"I'm almost there," he said, his breath from the climb ragged in the open mike. "Esteban: can you hear me over this circuit?"

The soft voice came back in his earphones. "Yes, Jack."

"Any word from the *Ganso*?"

"I am picking up something that could be radar from one of their probes. I cannot be sure yet."

Jack was walking with a slight stoop because of the low ceiling in the passageway. He had passed two hatches that looked secure. The third looked okay too. The hissing was still coming from somewhere up ahead.

Suddenly a sound like a struck gong beat at him through his suit. He felt the vibration rise up his legs through the soles of his boots.

"Jack, are you all right?" Tina asked in the helmet phone.

He had staggered but not lost his footing. "No problem. Esteban: any further damage from that one?"

"No, Jack."

Just ahead he saw the problem hatch. The hissing was very loud now, almost a shrill whistle. As he came up to it, he saw the trouble: a piece of heavy cable wedged in the seal at the bottom of the hatch. On both sides of it the gasket material bent inward by the violent rush of the escaping air.

Jack grabbed the end of the cable in a gloved hand and tugged. It didn't budge, held in place by the pressure of the hatch mechanism.

He placed a booted foot on the wall next to the hatch to brace himself and pulled on the cable with all his weight.

Nothing. If anything, the scream of air was louder now.

"Esteban: a piece of cable is jammed in the hatch seal. The only way I can get it out is if you jog open the hatch while I pull it out."

"That sounds dangerous, Jack," Tina said. "You could be pulled into the cargo bay!"

"Not unless Esteban chooses a really bad moment to overload. I'm ready when you are, Esteban." He held the cable end in both hands.

Esteban's voice came over the circuit: "I am opening it . . . now."

The hatch slid back and a storm of air beat him from all sides, roaring through the rectangular slit that had opened. He saw it become visible streams of white as water vapor condensed out of the rapidly cooling, expanding gas. It took all of his strength to pull the length of cable out of the hatchway, as he was pushed violently toward the slit.

It was over in a second. Esteban had slammed the hatch. The passageway was silent. Jack looked at the short length of cable in his gloved hand.

"Cargo bay four is sealed," Esteban told him. "Thank you, Jack."

When he got back to the control room, Tina was already getting out of her suit. Jack walked in carrying his helmet under his arm. He wiped his brow with his glove. "Let's hope we don't open up any more holes in this tin can," he said.

On the screen above his chair, the "X" had moved noticeably closer to the white dot.

He was climbing out of his suit when the speaker buzzed.

"*Sierra,* this is *Ganso*. We have you on our radar." It was Brightbar's voice, loud and clear.

Tina threw her communicator switch. "*Ganso. Sierra* here. Ah, we're just fine. How are you?"

"Hello, ma'am," Brightbar said, sounding relieved to hear from them. "Communications in this soup have been really bad. I've been trying to raise you for the last hour or so."

"I haf a picture from probe seven," Esteban announced. The B Screen winked to life.

It showed a giant world of swirling gas—pale red, like some ancient god's watery eye. A nimbus of glinting rings—thousands of them—encircled it in a wreath. And in the foreground, against this setting, drifted the dark bulbous shape of the *Ganso d'Oro*.

VI

"Well," Brightbar said, clunking his helmet down on the low table between their chairs, "you two don't look any the worse for wear. I don't mind telling you, though, I was plenty worried about you there for a while."

Tina was fascinated by the size of the plastic bubble that Brightbar wore as a helmet. She had to tear her gaze away from where it leaned against the panel of the food compartment.

"Not as worried about us as *we* were," Jack was saying. "Did the *Ganso* take any damage?"

"Not so's you'd notice. A few nicks here and there. We were lucky enough to pop out of white a lot nearer to Penelope here than you did." His huge hand, still armored by the suit, had waved to indicate the ringed world on the viewscreen.

"Penelope?" Tina said.

"Well, I sort of got to calling her that." The giant couldn't meet her eyes. "Sort of after a lady I knew once on Moonlight."

Penelope, Tina thought. *Well, why not? Wasn't there a story once about a Penelope who wove a tapestry and then unravelled it again? Those rings—so thin and delicate—some of them look braided. It could be a tapestry. . . .*

The Mendelkind put a massive boot up on the metal table and leaned on his knee. He regarded the image that Esteban's onboard camera displayed. "Real pretty, isn't she? Just like I remembered her . . ."

Tina glanced at the viewscreen, noticing the waving cable that Brightbar had used to crawl over to their ship. Somewhere, out of view, it was linked to a hatch on the *Ganso*.

"This orbit we're in now," Jack was saying. "What ring will it carry us through?"

Brightbar cracked a grin. "Why, gold, of course." He winked at Tina. "That's what you came for, isn't it?"

Jack stepped up to the screen, where the myriad rings twinkled brightly. "It's hard to believe that those things are precious metals."

"All kind of metals," Brightbar cor-

rected him. "The base and the precious. But all pretty pure."

The reality of it had sunk in with Tina too. "How could they form—separated in perfect rings like that?"

"Beats me, ma'am. Some day somebody'll probably figure it out." Brightbar rubbed his chin with a gloved hand. "I *did* notice something, though . . ."

Tina looked at him, but Jack didn't turn from his rapt gaze at the screen.

"I've been making a map of the rings. Filling in the gaps from what I remembered from my last stop in these parts."

"You noticed a pattern in the rings?" Tina said.

The Mendelkind regarded the tabletop under his boot. "Well, I always knew there was a pattern to them. Sort of roughly, they're arranged by atomic weight. The lighter elements like vanadium and chromium, they form the inner rings, close to old Penelope. Then, next out, there's your iron and nickel and such like. Farther still, and you've got things like molybdenum and rhodium and silver. That'd be about midway through the rings. Next after, comes your rare earths—a whole series of bands. Most of that stuff's oxide—it must have reacted with water ice." Brightbar drew an imaginary ring on the tabletop with a gloved finger. "Now out where we are, you've got tungsten, rhenium, the platinum group. Gold, of course. Then out, beyond, the real heavy elements—lead and uranium."

"It sounds pretty straightforward to me," Tina said.

"Well, you see, that's the thing," Brightbar told her. "It's not quite exactly matched up with the periodic chart. Almost, but not quite. Like, you'll find a second ring of nickel somewhere out of place. Like in the middle of the rare earths, say. There's a lot of what you might call anomalies like that. It's hard to figure . . ."

"Speaking about anomalies . . ." The word had jolted Jack out of his reverie. He jerked his gaze away from the rings. "What happened to our communications back there?"

"That one's a little hard to figure, too," Brightbar said, meeting his stare. "The drop-out in whitespace that caused the drift—that's common enough, I guess you know . . ."

"No, I *don't* know," Jack said.

"Well, it is," Brightbar went on. "Gravitational effects from inverted mass anomalies. When two ships in hyperspace try to communicate, it sometimes happens. Usually their correction routines can compensate. In our case, it was bad enough that they couldn't. . . . That's not what bothers me, though." He shifted his weight and leaned back on his knee. "When we popped out in this protosolar cloud, I'd expected that communications would have been back to normal. But there's a new wrinkle in here—heavy radio interference from that young sun."

Jack frowned. "You mean that this system has changed since you were here last? How long ago was it again?"

"A good thirty standard years, I guess. Just an eyeblink as these stellar processes go, I know. Still has me bothered, it does. Now Whipple and I, we had no reason to use our PMTB in here—nobody else to talk to, you know. But I'm sure we would have noticed the heavy radio noise that the sun's putting

out now. It just wasn't there thirty years ago."

"What do you think that means?"

Brightbar spread his hands. "I don't know. The system's still rapidly evolving. Some kind of starquake might have happened lately . . ."

"Starquake?" Tina said.

"They happen in these young systems, ma'am."

"*Sierra,* this is *Ganso* . . ." It was Dobson's voice from the speaker.

The Mendelkind reached down to Jack's chair and toggled the switch. "I didn't imagine it was anybody else," he said with a smile.

"Your program has just informed me that our first pass through the ring plane will occur in eighty-eight minutes. Three thruster burns will be required forty-seven minutes before that if we are to alter our trajectory as planned. Both ship's navigational programs are phase-locked on tight Y-band. . . ."

Brightbar winked at the two of them. "Sounds just like he knows what he's doing, doesn't he?" He toggled the switch again. "I read you, Dobson. Keep your pants on, I'll be right over."

Jack's face lit up. "So we're going right after the gold."

"I don't see why not," Brightbar said. "Your number four cargo bay's beyond repair and I'd just as soon not get involved in a major welding job in a place like this, even if we could fix it. I figured we'd slide into an equatorial orbit just a shade above the ring plane. Then we can take some time getting you folks familiar with the hot buggies."

"Yes," Tina said. "If I'm going to have to fly one of those things, I'd like some practice."

Jack put a hand on her arm. "Tina, nobody expects you to . . ."

She took a step out of his grasp. "I'm going to pull my load on this trip, Jack. I can do it." *I'm going to do it,* she told herself.

Brightbar sniffed and rubbed his mountainous nose. "Oh, you'll be able to handle them all right, ma'am. It's as simple as driving a hovercar, like I showed you back at the Port-Wheel. It just takes a little getting used to, that's all." He reached down and retrieved the massive bubble of his helmet. "Well, I guess I best get back over to the *Ganso* before Dobson starts pushing buttons on his own. . . ."

The Mendelkind stopped short. "Oh, I remember now. I was going to ask your computer something. You've got a much better magnetometer here on the *Sierra* than I have on that old clunker across the way . . . Esteban: would you put up a magnetic profile for us, please."

"It will take just a moment," the accented voice responded.

"Why do you need that?" Jack asked.

Already a spherical grid of lines was forming on one of the screens.

Brightbar stared at it, the helmet under his arm. "You never can tell. Sometimes these gas giants have . . ." He stopped as more of the diagram was filled in. It showed a fan-like array of magnetic field lines that sprouted from both poles and bulged strangely at the equator. "Well, would you look at that!"

Tina followed his gaze. "Something unusual?"

"I should say so," Brightbar said. "That there might explain why Whipple

and I couldn't get our hyperdrive going until we were well clear of Penelope. A very intense and what they call asymmetrical magnetic field. Interesting. No problem, though. We'll just back off a ways on reaction drive. Something to bear in mind. . . ."

When the two ships had completed their orbital maneuvers and were gliding in tandem a kilometer above the plane of the rings, Jack and Tina had ferried over to the *Ganso* in a small shuttle. The view of the rings from that perspective had been awesome: an ocean of countless glinting, tumbling stones, from boulders the size of a hovercar down to the smallest pebbles that their eyes could resolve. All set against the watchful watery red eye of Penelope herself.

Against Jack's insistence, Tina had convinced Brightbar to take her out first in one of the hot buggies that would be used to gather their riches from the rings.

Jack stood with Dobson in the control room of the *Ganso,* watching the armored sled drop away from them on the viewscreen.

"She's a most courageous woman, Mr. Deiner. You should consider yourself fortunate to have found such a prize."

Jack was still grappling with mixed emotions—fear for Tina's safety and annoyance at her pig-headed insistence to be the first trainee in the oddly shaped craft. He glanced over at Dobson. The man wore his familiar wolfish grin.

"She's trying to prove something, that's all," he said.

"Still, it shows pluck. Intestinal fortitude, eh? Not the most comely physique one could imagine, perhaps . . . but breeding will tell, as they say." Dobson scratched at his stubble. "Yes, in a short time, you and Miss Petulack will be able to retire from the scene of common men with the lion's share of this enterprise between you. Not only a fortune, but a good woman, as well. I envy you that, Mr. Deiner."

The hot buggy had dropped down almost to the level of the rings. It was little more than a dot on the screen now.

Jack was too engrossed with the glittering spectacle of the rings and the tiny dot that had disappeared among them to look away. "You got that wrong, Dobson," he said. "Tina and I are . . . friends, that's all."

"Oh, so I've misinterpreted your relationship," Dobson said, and Jack could feel his grinning expression without looking. "You two have been almost inseparable since I've met you. . . . So it's just a tumble in the hay, as it were. Perhaps Miss Petulack has a different perspective on the matter, though. She seems to be looking for some stability in her life. A fine woman like that should have someone to take care of her. . . ."

Jack had Dobson's shirt front bunched in his fist before he even realized how the anger had boiled up within him. "Tina doesn't need anybody to take care of her, Dobson!" he said, inches from the other man's face. "And if you try anything with her, you're going to have trouble from me like you can't imagine!"

His shirt in Jack's hand, almost pulled from his feet, Dobson grinned into Jack's face. "Quite so, Mr. Deiner,"

he said. "Your point on this matter is duly noted."

Tina remembered a hovercar trip along a winding mountain road on Olive I when she was a girl. They were nearing the end of a long journey to visit a sick relative and her father was at the wheel. Suddenly a snowstorm had hit with terrible ferocity just as night had fallen. The driving snow had appeared out of the blackness and pelted the windshield of the hovercar. There had been an abstract unreality to it. It had frightened her.

"Now ease off the forward thrusters," Brightbar said over the helmet phones. "Let her drop down a ways . . ."

The hot buggy was skimming the upper edge of the ring and the small tumbling pebbles on the viewscreen were like a snowstorm.

"We'll just make a light pass for now," the Mendelkind said. He was kneeling behind her in the single-seat cockpit, his huge suit taking up every inch of the cramped storage area. "Throw the switch that opens the hopper."

The pinging of the particles against the armored hull was rising in volume as they dropped lower into the maelstrom. Tina threw the indicated switch.

Somewhere below and behind them a servo-motor whined into life. In seconds the pinging became a battering crescendo of metallic clunks. The whine stopped just before it was inundated with the furious drumbeat of the ring particles hammering against the inside walls of the hot buggy's hopper.

"How will we know when it's full?" Tina asked, trying to adjust to the assault on her eardrums.

"It'll take quite a while to fill this thing," Brightbar told her. "You've got a gauge there that shows the level in the hopper. Right over from the attitude control."

The sound became a physical presence in the tiny cockpit. Tina could feel the vibration through the throttle control in her hand. Without the sound-deadening protection of her spacesuit, she believed it would be more than she could stand.

"What keeps this stuff from falling out?" Tina asked, trying to get her mind off of the sound.

"How's that, again?"

Tina adjusted her mike volume, until her own voice startled her. "The ring material. What keeps it in the hopper?"

"There's a series of baffles in there," Brightbar told her. "Gravity does the rest. Okay now, close the hopper and wait until you have a light that tells you it's locked. Then hit the lift thrusters a little to get us back up above this stuff."

Tina followed the instructions. The drumbeat faded to pinging once more. Slowly they rose above the ring and the cockpit became silent.

"Your hopper gauge shows you've picked up about a half-ton of material on that pass," the Mendelkind said. "Now turn on the heaters."

Tina searched for the appropriate switch and threw it. A temperature gauge began to climb almost immediately. A pressure indicator next to it took a spasmodic jump. Tina visualized the frozen methane and ammonia from inside the rocks streaming from vents in their golden skins.

Something banged in the hopper behind them. Then again.

Brightbar chuckled over the phone circuit. "When the water starts to cook out, it knocks the rocks around. They're like little rockets back there."

The isolated bangs increased in frequency. It sounded like popping corn.

After a few minutes the sound subsided. Tina noted that the pressure in the hopper was now very high.

"Time to open your vents," Brightbar told her. "Watch your attitude control. It's got some force behind it."

Tina hit the vent switch and there was an immediate tug on the small craft as the hot pressurized gases hissed out of the hopper. She imagined the plume they must have made as they recondensed behind them.

What was left now in the hopper was rock and metal—lighter and more compact than the unprocessed material of the rings. What would fill the cargo bays of the two ships would be high-grade stuff—precious metal and some rock which an ore processor on Banjoqueen could easily separate out. The hot buggies had been designed to process any kind of icy ore, but they worked just fine on the stuff of the rings.

"Okay, ma'am. You can make another pass now. Drop her down easy . . ."

Again the snowstorm on the viewscreen. The pinging on the hull changed to an ear-deafening drumbeat as Tina opened the hopper doors. The minutes crawled by as the sound surrounded them.

"Pull up!"

Tina had been mesmerized by the sound. Brightbar's voice caught her by surprise. Now on the viewscreen she saw it—a massive chunk of metallized ice and rock the size of a house, rolling through the snowstorm straight at them.

She reacted without further thought, leaning on the thrusters and arcing them away from the path of the behemoth. It sedately tumbled by them twenty meters to their left.

Tina could hear Brightbar's breath in her earphones over the cacophony from the hopper. "You did good there, ma'am," he said at last. "If you tried to pull up over that thing, like I was telling you, we wouldn't have made it. You got good pilot's nerves, like they say . . . but if you don't mind my saying it, keep your eyes on that screen. . . ."

Brightbar tossed the glittering object to Jack, then began to work out of his spacesuit.

"Why, it's almost like foil!" Jack said, turning the crumpled hemispherical shell in his hands. The cabin lights of the *Ganso* reflected off of the irregular planes of the object, casting a network of light across Jack's face.

Dobson leaned over Jack's shoulder, catching some of the reflected glimmer. "The first fruits of our enterprise," he said. "Just imagine our holds filled to brimming with such shards. . . ."

Tina brushed at her hair, where perspiration had plastered it to her forehead. "When the gases and water are boiled off, the metal skin falls off in a shell like that," she said. "Just like peeling the rind off of a citron."

Jack placed his hand in the concave recess and ran his fingers over the inside surface. His eyes, in the reflected radiance, had a faraway look. "There must be millions of tons of it out there,"

he said. "Enough to supply the whole galaxy!"

Dobson reached for the object. Jack's fingers surrendered it reluctantly.

"And not just gold," Dobson said, as he juggled the shard to estimate its weight. "Platinum, osmium . . . imagine the impact this will have on the precious metals market!" A frown flicked across his features. "That's something we hadn't considered. We must be extremely cautious about how we release our metal into the marketplace. And about what story we tell about how we came upon it."

Brightbar pulled off a boot and wiggled his enormous toes. "Sounds to me like you fellows got your money spent already," he said. "Don't forget that we got a heap of hard work in those buggies ahead of us before those cargo bays are full."

"Dobson's got a point, though," Jack said, his eyes still distant. "If word got out about these glory rings, every prospector in the Near Arm would be out here, loading up his ship. The market for precious metals would take a nose dive."

Brightbar was still struggling with the other boot. "We'll have our goods converted into cash long before that ever happens."

Jack took the golden shard back from Dobson. "But won't somebody get suspicious that we've found a glory ring when we try to sell material in this form?"

"Well, what Whipple and I did, we took our goods to a small smelter on Banjoqueen—over in Paydirt it was. We gave the fellow who runs it a quarter share to keep his mouth shut. Had the stuff cast into ingots. Then we sort of dribbled them out for cash on a couple different worlds. A little at a time, sort of . . ."

"Still, there's four of us this time," Jack said. "And we'll be bringing back a lot more than you and Whipple did. The chances of word getting out about our having found a glory ring are a lot more likely."

Dobson scratched his cheek. "I have another thought, gentlemen. What if we stake a claim?"

"To . . ." Jack waved the shard toward the viewscreen, where the gold ring sparkled against the field of red. "To the whole planet, you mean?"

"There are precedents, if I'm not mistaken," Dobson said.

"I'm against it," Brightbar told them, giving up on his second boot for the moment. "Number one: The claims office on 'Ceti is controlled by big mining interests who likely as not will tie up the claim in litigation until they can move in themselves." He ticked off another gloved finger. "Number two: I'm a space-digger, not a businessman, which is what it will take to set up a mining operation out here. Number three: Like you said, all those precious metals will devalue the market price of what millions of poor dirt-diggers and space-diggers have been grubbing around their whole lives for. And number four: I think there's something special about glory rings." Brightbar looked at them and he wasn't smiling. "I think they were made so's people like me and you and lots who come after have something to dream about."

"You must be joking," Dobson said.

* * *

VII

Days passed into weeks, as Jack and Tina and Dobson each gained proficiency in the hot buggies. They worked a grueling schedule harvesting the treasure of the rings, sleeping in shifts so that at least one buggy was in use nearly all the time.

Slowly the cargo holds of the two ships filled. One bay on each was filled from the gold ring, then they displaced their orbit a bit inward toward the featureless red eye and began to gather metals of the platinum group.

Jack and Tina slept together always—an understanding in the schedule of work which was not begrudged by Brightbar and not referred to by Dobson. Despite their closeness, there was often little time or energy for anything but sleep.

"Jack, are you asleep?" Tina was staring through the darkness of the *Sierra*'s control room at the panel of colored lights.

"Mmm?" Jack stirred on the pillow next to her, slowly rising to wakefulness. "What's the matter?"

Tina hugged her pillow. "Never mind. I'm sorry, Jack. Go back to sleep."

"Something bothering you?" He waited.

Tina lay there a moment, not answering. Then she sat up in bed and looked at him across the darkness. "I . . . I'm worried about you, Jack," she said.

"What? That buggy hatch thing? That's just a bruise. . . ."

"Not that."

"What then?" By now he was fully awake.

"I . . . I think the money . . . the 'goods,' as Brightbar says, that we're collecting out here. They mean an awful lot to you. . . ."

"Well, we're not out here for our health, you know."

"I don't mean that. I mean it's become too much . . . an obsession. Like Dobson."

Jack laughed. "I don't think I like the comparison," he said.

Tina touched his hand under the covers. "But it's true, Jack. The way you've been driving yourself. I . . . I see something in your eyes sometimes, when you don't know I'm watching . . ."

Jack grabbed her where she was ticklish. "I only have eyes for you, baby," he said.

Tina exploded with laughter. "Stop it, Jack!" She turned away from him. "I was trying to be serious."

"Okay," he said, "so I've got gold fever . . . I go off into a Silas Marner trance every time I'm around the stuff . . ."

Tina kept her back to him. "Something like that," she said.

"Bullshit! So maybe I'm a little dazzled by it all. We all are to some extent. Even Brightbar—and he's been here before!" Jack rubbed her back. "Christ, Tina, how do you expect a starving kid to act when you plunk him down in a cookie factory." He patted her shoulder and settled back down on his pillow. "Now get some sleep, kid. You're tired."

Tina lay in silence for a few moments watching the colored lights swimming

in the darkness. "It's more than just that, Jack . . . you're changing. . . . Yesterday, that argument you had with Dobson about how we're going to divide up the shares . . . it scared me a little. . . ." Her voice faded to almost a whisper.

"That bastard wanted our shares cut because our number four bay isn't useable . . . Brightbar and I straightened him out, that's all. Now let's knock this off and go to sleep."

Tina felt her heart beating. It was true—Jack was changing. Like the freighter pilot. Like the prospector on Banjoqueen. It always happened one way or another. She felt something wet against her face on the pillow. *I must be crying.*

But it didn't have to happen again. *Jack's had a rough life. It's made him hard on the outside—I know what that's like. But inside there's a warmth to him. Even Brightbar saw it. The metal in these rings can't poison that.*

But it was more like a question than a firm belief.

"I love you, Jack," she whispered in the darkness.

The sound of his breathing told her that he was already asleep.

"I wouldn't ask, if I wasn't so dog-tired myself," Brightbar said.

Jack already had his suit on and was studying the blueprint of the *Ganso*'s number two cargo bay on one of the viewscreens. "No problem," Jack told him. "Now just explain to me exactly what I'm supposed to do."

The Mendelkind stepped up to the display and pointed. "This relay triggers the motors that open the diaphragm. It's supposed to trip with the signal that the control circuit here on the board sends down there when somebody in a buggy wants to dump a load. But it's only been working right about half the time, I'd say. I've traced the circuit and the proper signal goes down when the radio code comes in from the buggies, so it's got to be a mechanical problem."

"I got you," Jack said. "How do I fix it?"

"I figure some rock dust must have got up in the mechanism. Just blow it out with a little gas from your tanks. Shouldn't be much of a problem. Dobson said he was going to do it the other day, but I guess you know how it goes with that guy. . . ."

Jack nodded. Dobson had been shirking all the work assignments that were not directly related to gathering material from the rings.

Jack donned his helmet and set off into the dark corridors of the *Ganso*.

This ship was older and had seen considerably more use than the *High Sierra*. Riveted steel plates, streaked by corrosion, replaced the soft green carpeting of the other ship. When Jack found the appropriate hatch to a cross corridor, it took every ounce of his strength to pry open the massive hinged disk and dog it closed behind him. Lighting in the cross corridor was poor and when he found the hatch to the number two cargo bay he found himself fumbling with the lock mechanism in the dim light.

The hatch gauge showed one atmosphere pressure in the bay, so that a leak around the iris diaphragm where the buggies dumped their loads wasn't the

problem. Obviously he was doing something wrong.

Then, over the phones, he heard Brightbar say, "Give that hatch a good swift kick, if she sticks on you."

Jack did as he was bid and was rewarded by the sound of the latch snapping open. Pitting his weight against the weight and corrosion of the hatch, he managed to swing it open.

Inside was pitch blackness. Reaching inside the hatch frame, Jack found a switch that turned on some floodlights.

A cavernous room was revealed. The hatchway where he stood was three-quarters of the way up to the rounded metal ceiling. The bay was about half filled with platinum shards, glinting dully far below him. Directly opposite Jack the massive iris diaphragm and its associated control motors hung on the wall like an abstract sculpture. The hatchway led directly onto a catwalk that ringed the entire room.

Jack stepped in and pulled the hatch closed behind him. It was the one point that Brightbar had grilled them all about. These ore ships had been designed for economy of operation. The bays had no airlocks on them because it would be a rare occasion, like this repair mission, that would require a human to enter them. So you locked yourself in—your fate, for the moment, wedded to the integrity of the room—while the rest of the ship remained safe from decompression.

With a little unease, Jack rechecked the seals on his suit. The faulty relay was in a control cabinet immediately below the huge iris on the opposite wall—a hundred-meter walk and then some.

As Jack treaded the narrow catwalk, he watched the soft lustrous metal glisten up at him. *Just this much,* he thought, *and a man could be a king!*

He nearly stumbled, catching himself with a gloved hand on the railing. A close call. A tumble over that rail would have broken his back in the ship's artificial gravity. *Dead on top of a fortune in platinum. An ironic way to go for a guy who didn't have a credit in his pants a month ago.*

Keeping his eyes on the catwalk in front of him, Jack made it to the control cabinet. Rock dust covered the catwalk and railing at this point, just below the diaphragm. Ship's gravity had pulled the light powdery stuff down this wall as the loads from the buggies had been dumped. A poor design feature of the *Ganso*. Obviously Brightbar had been right about the problem.

Jack snapped a screwdriver out of the utility belt on his suit. Four machine screws held the control cabinet's front panel in place. As he undid them and slid the panel away, a puff of dust blew up at him. Dust was the problem all right.

The wiring and mechanisms inside the cabinet were orderly but intricate. It took him a full minute to find the offending relay. It was an old-fashioned fast-throw solenoid about the size of a domino. He'd seen these on the freighters in the merchant marine and they had been outdated equipment even then.

Jack toggled his helmet spot and peered at the thing. There was a fine coating of grey dust on the coil. He retrieved a short length of light pressure hose from the pocket on his right thigh and snapped it into the auxiliary cou-

pling on his chest. Squeezing the small valve on the free end of the tube produced a burst of air from his tanks.

He was just reaching into the cabinet with the hose when a loud clang startled him. It had come from right above his head—the iris diaphragm.

One of the buggies had just docked!

It had to be Dobson, Jack knew. Brightbar was in the *Ganso*'s control room and Tina had been rechecking Esteban's probe data under the Mendelkind's instructions.

What's that son-of-a-bitch trying to pull!

"Brightbar!"

The helmet circuit was silent.

Jack looked up at the huge metal spiral on the wall above him. *What the hell's going on here!* "Brightbar, Dobson's just docked one of the buggies to bay number two!"

Everything was ominously quiet.

Then, one sound: the sharp metallic click of the domino-sized relay in the control cabinet in front of him.

Jack began running almost instantly, the forgotten hose whipping behind him. Already he could hear the thunderous surge of the iris motors as they came up to speed. He could feel the light metal structure of the catwalk bounce under his heavy footfalls.

Okay, now, think—what's going to happen? Jack could hear his own labored breathing on the open helmet circuit. *Theoretically, the hot buggies make a pressure-tight gasket seal with the docking ring on the hull. That's to prevent a massive pressure loss that would stir up the pile of metal in here and prevent the buggy load from dumping in an orderly way. But something's up. Brightbar should have told Dobson to stay away while I was in here. Anyway, the control circuit to open the iris was supposed to be disabled while I was down here, to prevent a pressure-loss accident. I saw Brightbar do it.*

The motors were roaring now. Jack stole a glance over his shoulder—the huge spiral eye was opening, the heavy metal plates that composed it slowly sliding back to reveal a dark hole in the center. Shards of metal were beginning to trickle down from it.

He was caught in mid-stride when the ship's gravity generators failed. It felt like walking through the ocean surf and stepping off the edge of a sand bar. The catwalk was no longer under him—he was tipping up and over the railing. He saw the catwalk and railing go by his suit visor as he tumbled out into the void. As it passed below him, he saw the pile of glinting platinum and rock stir like a breeze-wafted sea. Now he was turning in the air, the ceiling and wall coming into view. It had been a timeless moment, perhaps a second, in which his mind did not function.

Then Jack saw it—hanging like a shimmering cloud in front of the gaping hole in the iris—a ton of rock and platinum shards. He was between it and the floor of the bay! If the ship's gravity returned right now . . .

Muscle memory returned from his merchant marine training. Jack kicked and waved against the ocean of air, trying to guide himself back toward the catwalk. *No good,* he thought. *Too slow.*

Then he remembered the flapping hose, still linked to his auxiliary tank coupling. He fumbled for it. The motion

caused him to tumble. After what seemed an eternity, the small valve was in his hand. Two squirts of air stopped his pitch and roll. A second of disorientation and he had located the catwalk. A tumbling hemisphere of metal drifted past his faceplate. Then he held open the hose valve. With interminable slowness the catwalk drew nearer. He felt a drop of perspiration fall off the tip of his nose. He fought the temptation to glance up at the deadly cloud of precious metal above his head, knowing that a sudden movement could easily start him tumbling again.

Seconds ticked by. The catwalk approached as in a dream. Twenty feet, possibly. Only the tiny hiss of air and the sound of his breathing broke the silence. Fifteen feet. Ten. His gloved right hand holding the light tubing at an awkward angle behind him, his left stretched out, fingers groping toward the rail. Six feet. Four.

His fingers clutched the railing bar like a trap. *Safe*. He dropped the hose end and was reaching up with his right hand when suddenly he felt himself dropping. His fingers clutched convulsively around the bar as his own weight almost pulled his left shoulder out of its socket. A sound like thunder behind him, as the suspended cloud of rock and platinum shards rained down on the pile in the bottom of the bay. He stretched up his free right arm, groping for the railing above his helmet. Something hit him hard in the back. He could feel his grip slipping. Then he reached the bar with his free hand. Something shattered against the top of his helmet, coating his faceplate with dust. Now he was painfully lifting himself up over the rail.

A giant gloved hand gripped his arm, helping him onto the catwalk. It was Brightbar, motioning something in Amersign with his free hand.

"I don't care what he says!" Jack was raging in the control room of the *Ganso,* "that bastard tried to kill me!"

Dobson was sitting in one of the chairs, staring silently into his lap.

"He doesn't know enough about these program modules to pull anything like that," Brightbar said, keeping his deep voice in an even tone. "It had to be a glitch of some kind, pure and simple."

Jack felt flushed and he was still trembling a little. "I suppose you're trying to tell me the whole thing was a series of coincidences! The bay diaphragm override shorts out, the radio circuits go down, and the gravity generators fail—all at the same time!"

"They're all controlled through the same utility module," the Mendelkind said. "I know it sounds screwy and I'm wondering about it myself, but don't go flying off the handle."

Jack jabbed an accusing finger in Dobson's direction. "This son-of-a-bitch tries to make a platinum sandwich in there with me as the filling and you're telling me not to fly off the handle! What am I supposed to do! Thank him for not popping the buggy off of there and sucking me out into space? The only reason he didn't try that was that he'd lose his damn platinum that way, that's why!"

Throughout Jack's tirade Dobson didn't look up. His face remained expressionless.

Brightbar put a hand on Jack's shoulder. "Calm down, son," he said.

"You're still working your nerves off. You had a close one in there. But you've got no proof that Dobson did anything. If I thought he rigged that module to fail in that way, I'd run him out the airlock myself . . ." Dobson flinched just slightly at this, then returned to his impassive calm. "But I honestly think it was a series of glitches in the module." Brightbar gestured toward the viewscreen. "We've got a funny magnetic field out there and we've got heavy radio noise from the sun in this system. The combination could have affected the module. These kinds of things have been known to happen. . . ."

"I'll never believe that!" Jack said. "I say we lock him up in one of the storage compartments before he tries something like this again!"

"Now look," Brightbar said, his voice just a bit louder. "I'll check out that module real thorough the first chance I get. If I think it's been tampered with, I'll consider what to do next. Until then, it's a module glitch as far as everybody is concerned. We keep on going just like we've been."

Jack caught just a trace of a grin from Dobson out of the corner of his eye.

"*Ganso,* this is Tina."

Brightbar flicked the communicator. "What's up, ma'am?"

"I was working with Esteban here on some of that data from his probes and I think we may have stumbled on something. . . ."

Jack hit the switch this time. "You found out why we're getting all that radio noise from the sun?"

"No, not yet, anyway . . ."

"What then?"

"I think . . . well, Esteban thinks he knows how the glory rings formed. . . ."

VIII

"We just sort of got to talking about it," Tina said, watching Jack as he studied Esteban's diagram on one of the *Sierra*'s viewscreens. "He's almost like a real person . . . I told him that nobody seemed to understand how these glory rings could form . . ."

Jack was still coming down from his agitated state. He had insisted that Brightbar stay behind on the *Ganso* and check out the computer module, as well as keep an eye on Dobson until his guilt or innocence had been proven. He also had decided for the moment to keep the whole incident from Tina. Right now he was trying to clear his mind and comprehend what the diagram showed.

It was a picture of Penelope and her ring system—all in heavy outline. Superimposed on that was the strange basketwork structure that he had seen when Brightbar had called for a picture of the planet's magnetic field. A black arrow pointed toward the planet's northern hemisphere at an oblique angle.

"Esteban," Jack said. "Explain this, please."

"The arrow, Jack, represents a flux of heavy metal ions that is moving through this system . . . a remnant from the supernova that produced the Gum Nebula. My probes have picked it up at several locations. The direction of the vector is approximately what is shown on the display."

"And that produces the rings?"

"By chance it intercepts this planet's magnetic field at just the correct angle

so that some of the metal ions are deflected at right angles to the field lines.'' The display became animated now—the impinging black arrow touched the basketwork lattice and little arrows arced in gentle curves down toward the rings. ''Because this field is so intense, the metal ions are separated by their charge to mass ratios . . . You are familiar with how a mass spectrometer functions?'' The accented voice paused, waiting for Jack to respond.

''No, Esteban,'' Jack admitted, ''I never heard of a . . .''

''Mass spectrometer. A very old machine, Jack. They were used to separate and analyze mixtures: organic compounds, metals, and isotopes, depending on how they were configured. The material was first ionized in some manner, and then the ion stream was passed into a high-vacuum region where the ions encountered a very strong magnetic field. The field deflected the paths of the component ions to varying degrees. The amount of deflection was proportional to the ratio of the ion's electrical charge to its mass. Collectors, counters, or photographic plates picked up these deflected ions.''

Jack finally had the image. ''Here, it's the icy rocks in the rings that collect them.''

''I am sure of it,'' Esteban said. ''They were perfect cold traps for the ionized plasma. The metal ions circled down, deflected by the planet's magnetic field, and spread out from each other in an array perpendicular to the planetary surface. At the equator they encountered the icy rings, where their spatial distribution was preserved. The rotation of the rings continually brought new cold traps around, forming the uniform pattern that we see here now. Over millions of years the layers of metals built up. The positive charge of the ions must have been neutralized by encounters with free electrons spiraling through the field in the rings.''

Jack watched the little metal-ion arrows in the display impinging on the system of rings. ''Brightbar mentioned the fact that the pattern of metals in the rings didn't exactly correspond to atomic weight. . . .''

''There are two reasons for that, Jack. First, the ions of a given metal might have more than one type of charge. There might be a nickel plus one and a nickel plus two, for example—these ions would follow different paths. Second, the magnetic field is not uniform, so that some ion paths might cross before they encountered the rings.''

Jack looked at Tina. ''It sounds right,'' he said. ''Esteban, why do you suppose these glory-ringed worlds are so rare?''

''That is apparent, Jack. A very unusual combination of conditions must be in place. An ice-ringed world with a very intense magnetic field and a heavy concentration of metal ions approaching it from just the right direction. Such conditions could only prevail near the site of a recent supernova, and even then they would be extremely rare.''

Tina put her hands on her shoulders, watching the cosmic mechanism displayed on the screen. ''I'm wondering why these glory-ringed planets have only been found in very young solar systems, though. That's what Brightbar said, wasn't it, Jack?''

Jack nodded. "Even if it takes this special set of conditions to form one of these things, you would think that they'd be a little more common among the older and denser star clusters. Lots of much older star systems were originally formed by the shock wave from a supernova. What do you say, Esteban?"

"That is an interesting—" Esteban's voice cut out in mid-sentence.

"What is it?" Tina asked.

"Probe four has been destroyed," Esteban said.

Jack frowned. "Collision with a planetesimal?"

"No," Esteban said, "I haf this system very well mapped by now. My probes were all adjusted to safe solar orbits."

"What knocked it out, then?"

"This is what I had feared, Jack. Probe four was in an orbit which took it in very close to the sun. I haf been attempting to get an indication of the cause of the intense radio frequency disturbances. . . ."

"Well, what's happening?" Jack demanded.

"A T Tauri wind is rising."

"A what?"

"A wind out of the sun, Jack. This phenomenon was postulated long ago. Soon after a young sun's thermonuclear processes are ignited—*soon* in the cosmological sense—an intense wind is expelled from it. This wind is believed to be responsible for the clean-up of young solar systems . . ."

Tina looked frightened. "What do you mean, 'clean-up'?"

"For some time there has been speculation as to how the excess gas and dust in a protosolar cloud is disposed of, once a young sun begins to shine." Esteban paused a moment, wiping the display of Penelope from the screen. In its place appeared the picture of the disk-shaped cloud they had seen before. "Several centuries ago, the concept of the T Tauri wind was formulated to explain the mechanism. At some stage early in the star's thermonuclear regimen, it suddenly expels a great puff of hot gas . . ." The display showed a hole opening up in the center of the disk, revealing the small white circle that represented the sun in its very center. As they watched, the hole grew rapidly, creating a torus with a dense inner rim, representing the swept-up gas and dust being carried outward. Already they could see the inner planets circling the star in the clear space of the opening hole. The torus became thinner and denser. The outer planets, and then the comets, were passed. Now it became very thin—a smoke ring blowing off into interstellar space. Finally it disappeared beyond the frame of the picture. What showed now on the screen could have been any normal mature solar system.

Jack swallowed. "How long do we have?"

"Based on readings I'm getting now from probe three . . . fifteen hours. It is blowing very hard, Jack."

Jack stabbed at the communicator switch. "*Ganso*, this is *Sierra* . . ."

"I was just getting ready to call you, Jack," Brightbar said over the speaker. "You were right, after all. Dobson rigged that module to fail. I never would of thought he knew enough . . . he must have been studying the system

manuals. Anyway, I got that character locked up in the john for now. . . .''

Tina looked at Jack. ''What's he talking about?''

''I've got bad news, Brightbar,'' Jack said. ''We've got fifteen hours to jump out of this system. Ever hear of a T Tauri wind?''

Jack was still sweating from the exertion of crawling through a cramped hundred meters of piping and circuitry in the hyperdrive service conduit. Tina was just completing a final check on the drive control and navigational modules as he slumped into the chair across from her. ''Everything seems to be okay,'' he said, ''at least according to what Brightbar told me to look for.''

Tina snapped a switch on the panel in front of her. ''The modules are loaded and ready.'' There was just a trace of a tremor to her voice. ''While you were down there, Esteban lost probe six.''

''What's the time look like?''

''Six hours until it reaches here,'' she told him. ''I just checked.''

He winked over at her. ''I'd say no sweat, except it's pouring off of me.'' He brushed back a wet mop of hair. ''Anyway, as far as I can see the *Sierra*'s ready to jump.''

''*Sierra,* come in,'' Brightbar said from the speaker. ''I found a little problem here during checkout.''

Jack had been in an optimistic, almost ebullient mood—a product of exhaustion and thoughts of the treasure they would be taking back with them. The wind out of the sun that was hurrying their departure had begun to seem like a godsend that would get them back to Banjoqueen before anything else could go wrong. Now that mood started to evaporate. ''What's wrong over there, Brightbar?''

''Hyperdrive tubes are dirty—both of them on the port side. I'm not getting good crystal continuity from the port engines. I figure we must have hit a snowball on our way to Penelope and the gases froze in there. Looks like I'm going to have to go out there and boil out the ice with a hand laser.''

''What about Dobson?'' Jack asked, feeling something heavy in the pit of his stomach. ''You want me to come over there and watch him for you?''

''Once I get my suit on, I'm going to lock him in the suit storage compartment. That'll be a good place for that guy until we get back to Banjoqueen. Don't worry, Jack, I can handle him without any help.''

The thought of Dobson being a threat to the giant Mendelkind *did* seem a bit ludicrous. Still, Jack had a bad feeling about this. Things were starting to go wrong again.

Jack sipped at some water, as he and Tina watched Brightbar on viewscreen C. The dark shape of the *Ganso*'s port engine cluster intersected half the screen. The Mendelkind was using muscle-response electromagnetic boots to walk across the gently curved surface of the hull. Every few seconds he would stop and play the beam of a hand laser back and forth across the engine housing. A few light puffs of white vapor would emerge from the open tubes each time he did it.

''How's it going?'' Jack asked over the open channel.

''I got to be sure about this,'' Bright-

bar said. "I don't want to have to come out here again. How's the time?"

"We've got about four hours," Tina answered for him. "Esteban's lost another probe."

"I want to be long gone when that storm hits. There, that should . . ."

Jack's gaze had drifted away from the screen. Now, as his eyes shot upward, the *Ganso* appeared to have moved. And Brightbar was floating free in space!

"Hello, *friends!* Would anyone care to hazard a guess as to who this is?" The voice from the speaker was unmistakable.

"Brightbar! Dobson got out!" Jack was stating the obvious. The figure on the screen was drifting away from them rapidly.

"That was real dumb of me," Brightbar said, with just a bit of strain to his voice. "The tools on the suits' utility belts . . . he must of used something to pick that lock. . . ."

"Very good," Dobson said over the open radio circuit. "One of your rare mistakes, Brightbar. Your other was rejecting the idea that we stake a claim to this world . . ."

Jack was already half-way into his spacesuit. "Keep him talking," he whispered to Tina. "I'm going to try to pick up Brightbar with one of the buggies." Jack still wasn't certain how much detailed knowledge about the operation of the *Ganso* Dobson had. Better to keep his mind off of any rescue attempt. Fully suited, he was off at a run.

"There's a wind coming, Mr. Dobson," he heard Tina say over his helmet circuit. "In four hours these rings will be blown away. And so will we, if we're still here when it hits . . ."

Jack dogged the hot buggy hatch closed behind him and in seconds he was dropping away from the *Sierra* in pursuit of Brightbar.

"Excellent!" he heard Dobson say. "You'd almost have me believing you, Miss Petulack. It's a terrible shame you've fallen in with such scoundrels. They were going to deny me my share, you know . . . yes, of course, you know. Well, the fortunes of war have shifted now. These rings belong to Alfred S. Dobson now . . . all of them . . . every glittering granule. . . ."

The viewscreen of the hot buggy showed only the carpet of particles that was the platinum ring. Jack snapped on a radar range finder and set it to sweep a broad arc in front of the small armored craft. Nothing. He had headed off in the right direction, he was sure. There was the dark hulk of the *Ganso* right above him.

"Mr. Dobson," Tina was saying, "you've got to believe us! There are less than four hours left. We're not sure how accurate Esteban's estimate of the wind speed is!"

Good girl! Jack thought. *Keep him talking*. Then, on the radar: a tiny white blip, just above the cloud of white backscatter from the ring. Brightbar was falling toward the ring! The ring particles would pound him to pieces!

Jack hit the thrusters, the acceleration pinning him against the padded seat.

"I was wondering why I haven't heard anything from your paramour, my dear," Dobson said. "And now I see! A heroic rescue, captured by the ship's camera . . . perhaps a dose of X-rays might be called for here. Now let us see if a non-technical type, like myself, can

manage to turn this big ship around and activate the fluorescence unit. . . .''

Jack felt a sudden chill run through him. The X-ray fluorescence analyzer on the *Ganso* used 30-kilovolt X-rays—just enough, Brightbar had said, to excite the surface atoms of heavy elements. The metal hull of the buggy would be protection enough, Jack knew. But carbon was a light element. The 30-kilovolt flux would stream through the plastic armor of a spacesuit. Brightbar would be dead meat. So he had even less time. And he still couldn't see the Mendelkind in the viewscreen.

''There you are, my big friend. Lined up in the cross-hairs, as it were. Now, how does one activate the X-ray tube. . . ?''

Finally Jack saw Brightbar on his screen. He was using a waving maneuver to try to stop his tumbling. Jack cut his speed and opened the buggy's hopper. He would have to slow down to a crawl; otherwise the baffles in the hopper would do the same job to Brightbar as the ring would.

''Ah, now I have it, gentlemen,'' Dobson was saying.

The buggy slowed to stop about fifty meters in front of the Mendelkind. He would have only one try. Jack nudged the forward thrusters.

''There!'' Dobson said, just as a muffled thud hit the inside wall of the buggy's hopper. Jack released his held breath and closed the hatch. The radiation survey meter on the control panel jumped off-scale.

''Brightbar, can you hear me?'' he asked, turning the buggy around.

''Sure, son,'' the heavy-breathed voice said. ''Thanks. You picked me up like a real pro!''

Jack accelerated gently back toward the *Sierra*.

''All but probe seven have been destroyed by the wind,'' Esteban was saying. ''We must leave now.''

''How long?'' Brightbar asked.

''It is difficult to judge now,'' the accented voice said. ''The wind speed has changed several times . . . perhaps an hour, perhaps much less.''

Jack and Tina were warming up the reaction engines, to blast them away from Penelope before jumping to white.

Tina looked up at the *Ganso* on the screen. ''W-we're just going to leave him here?'' They had long since shut off the radio circuit, cutting off Dobson's ravings.

''Nothing much else we can do, ma'am,'' Brightbar said. ''I feel real bad about it.''

''After what he tried to do to you!'' Jack said. ''You're a better man than I am, Brightbar.''

The Mendelkind shrugged. ''Not really, it's just . . .'' His eyes froze to the viewscreen. The *Ganso* was turning in space.

Brightbar's hands were suddenly throwing switches on the control panel. ''He's going to hit us with his hyperdrive!'' the Mendelkind said. ''The flux will catch us, no matter how fast we back out of here!''

On the screen, Jack and Tina saw the gaping drive tubes of the *Ganso* swing into view. Jack looked down at the panel. ''What are you going to do?''

Brightbar was still throwing switches. ''Only one way to save ourselves,

son . . . we've got to put a lot of something between ourselves and the *Ganso*. . . ."

Jack put a hand on the Mendelkind's forearm. "You're going to open the bays . . . dump all that metal out into space!"

Brightbar looked into his eyes. "That's right, Jack," he said.

"I won't let you do it!" Jack told him. "We've worked for that stuff . . . we've almost died for it!"

Tina touched his shoulder. "Jack, please! Brightbar must know what he's talking about!"

The Mendelkind motioned toward the screen. "Take a look for yourself. Dobson's going to turn us into vapor in the next few seconds, if I don't jettison that metal."

On the viewscreen, the *Ganso* had completed its turn. They were staring down a set of gun barrels.

Jack felt something die within him. Maybe it was better dead. "Go ahead!" he said.

Brightbar threw a switch and the ship's gravity disappeared. Holding himself close to the panel with one hand, he threw a second switch with the other.

Floating above one of the chairs, his hand on the carpeted ceiling, Jack was at eye-level with the screen. Two billows of glittering metal and frozen gas blew out from the *Sierra* toward the drive tubes of the *Ganso*. A cloud of gold and platinum formed between the two ships.

Gravity returned an instant later. Then Jack and Tina were hurled around by a sudden tug of acceleration.

Jack grabbed Tina's arms and guided her into one of the chairs, bracing himself against its armrest. On the screen, the cloud of metal and its backdrop of the rings were already a little diminished by distance. Then there was a flash, like the single blink of a bright strobe, and only the rings remained. The *Ganso* was gone.

"He must have jumped," Jack said.

"Not in that magnetic field, he didn't," Brightbar told him.

Tina didn't want to believe it. "But the *Ganso*'s not there!"

Brightbar leaned on the control panel and sighed with resignation. "Reflections from that metal must have set up resonances in the drive crystals. The control circuitry couldn't shut the engines down fast enough. It all happened in microseconds . . . Dobson wouldn't have known what was happening."

Tina stared at the downcast face of the Mendelkind. "You mean, he's . . ."

Brightbar nodded. "Gone," he said.

The shockwave of vaporized metal that had been the *Ganso* hit them a minute later. By the time it had passed, Penelope was at full-orb, majestic and beautiful on the screen.

Brightbar patted the empty chair by his side. "Have a seat, son," he said to Jack. "We're ready to jump."

Epilogue

They were in whitespace for nearly a day before the first opportunity presented itself.

Brightbar was down in one of the bay corridors checking the hatch seals, leaving Jack and Tina alone in the control room.

Jack seemed reluctant to look at her. "Tina?"

"Yes, Jack?"

"I was thinking . . ." He banged his fist on the light panel in front of him. "This is really dumb . . ."

Tina's face remained impassive. "What is it, Jack?"

The words came out in a burst: "You want to marry me, or what?"

She was out of her chair and in his arms. There were tears welling in her eyes. Then they kissed, holding each other tightly, as if afraid to let go.

"I'm still a dumb, penniless . . ."

She put a finger across his lips. "You're a good man, Jack."

In her mind, amid a swirl of thoughts, Tina saw the rings again—where they had cast their fate and, perhaps, won after all. The glory rings—that delicate tapestry—gone now, she knew. Penelope's web unravelled once more.

With Tina in his arms, Jack saw the rings too, now with a new perspective. They had been a dream, a beautiful fantasy. But now morning had arrived. His eyes were open, and life lay ahead. The rings and the dream were a part of the past—blown, like the down of a thistle, on the morning wind. ■

GLOSSOLALIA

Arlan Keith Andrews, Sr.

Chances are
you've heard
this story before,
but it
was a bit garbled.
This is the way
it really happened....

From: Royal Department of Development
To: Babylonia-Assyria Building Erectors, Ltd.Marduk 3, Year of Reign 6
Re: Ziggurat Construction Contract
Dear Sirs:

The Royal Commission of Public Works hereby announces that your firm has been awarded the contract to build the new Ziggurat of Nebuchadnezzar in downtown Babylon, pursuant to the terms set forth in the Akkadian Contract Manual (ACM). Contract tablets must be initialed in quadruplicate and two sets returned to this Office. One set must be kept at your engineering offices and one set at the construction site at all times. (Contract tablets will be forwarded under separate cover, in eight ox carts.)

Please be advised that the Commission requires that all drawings, correspondence, records, and documentation be executed in the international standard documentation language, Mesopotamian-Assyrian Cuneiform with Hieroglyphic Interpretations for Nineveh and Egypt (MACHINE language). Compliance with this standard will be monitored by consulting specialists from the Ishtar-Baal Monastery. These IBM consultants will forward weekly reports to this Office for review, in triplicate. File copies must be kept at both your headquarters and on the construction site.

Yours truly,
Royal D.O.D.

From: Babylonia-Assyria Building Erectors, Ltd.
To: Royal Department of Development
Marduk 8, Y.O.R. 6
Re: Ziggurat Contract, Simplification Thereof
Royal Sirs:

We are very honored to accept the contract to build the new Ziggurat in downtown Babylon. Please note that we have initialed all copies of the tablets, retaining two sets for ourselves. (Completed tablets will be forwarded under separate cover, in four ox carts.)

However, we ask to make a simplification in the documentation standard you propose. Our current procedure consists of digital recording on the standard Babylonian hard disks (i.e., using thin-fingered scribes scratching on wet mud disks, sun-hardened afterwards). To keep this heavy information flow at a minimum, may we offer a faster, alternate method? We suggest that the weekly reports be transmitted in a brand-new in-house language, Babylonian-Assyrian Summarized Interpretative Cuneiform (BASIC). This will allow shorter reports, reduced volume of reports, and fewer hernias for the scribes. We propose to send three weekly mini-disks and follow up with the larger MACHINE disks once per month.

Yours truly,
Ahshugar, Chief Engineer
B.A.B.E.L.

From: Babylonia-Assyria Building Erectors, Ltd.
To: Tarsus Instruments
Marduk 9, Y.O.R. 6
Re: Subcontracting for Data Processing for Ziggurat Contract
Dear Sirs:

This tablet is to inform you that your company, T.I., has been chosen as prime subcontractor for Data Processing for the new Ziggurat Project. We are very impressed with the hardware and

software you propose to utilize. particularly the new hand-held engineering tool, the protractor. We feel that integration of your new hand-held calculator and our graphic capability (compass and straight edge) will bring new sophistication to the construction industry.

Your new formatted documentation scheme, Phoenician-Originated Relief Tablets for Reading and Numbers, sounds extremely useful. We would like to review this PHORTRAN at your earliest convenience.

Ahshugar, Chief Engineer
B.A.B.E.L.

To: Babylonia-Assyria Building Erectors, Ltd.
From: Dravidian Engineering Consultants
Marduk 31, Y.O.R. 6
Re: Documentation Standards
Dear Sirs:

Now that the construction site has been cleared, we must point out that additional acreage is required for safe storage of the documents required by the Royal Commission of Public Works. Until such allocation is accomplished, the construction schedule may be jeopardized by the handling of the heavy flow of information into and out of the construction site.

Additionally, we had NO idea that you would be using the antiquated MACHINE, BASIC, and PHORTRAN languages for documentation. Our own sophisticated data staff uses only the modern Cuneiform-Oriented Babylonian Official Language (COBOL) or the Sumerian Nomenclature Organized by Official Linguists (SNOBOL). The translation of disks will require at least a three-fold increase in our storage requirements and a re-negotiation of the remuneration clause in our Subcontract. (Subcontract disks will be forwarded under separate cover, in all four languages, in twelve ox carts.)

Furthermore, if we are to pass on the appropriate documents to your multinational foremen, we simply MUST have interpreters to translate Dravidian to Assyrian and Assyrian to Dravidian. These A-D and D-A converters are absolutely essential!

Yours truly,
D.E.C.

From: Royal Department of Development
To: Babylonia-Assyria Building Erectors, Ltd.
Ishtar 13, Y.O.R. 6
Re: Schedule Compliance
Dear Sirs:

On-site inspection shows that the first three tiers of the new Ziggurat are very satisfactory and His Royal Highness is pleased with the progress. At this rate, we feel that the Pyramid Erection Regulatory Tablet schedule will be met. You will be eligible for the bonus for early completion if the PERT schedule can be beaten.

However, we do have a few changes to suggest in documentation procedures. Namely, we are willing to add a 10% contract cost increase for the construction of an adjoining documentation facility (or data base) on the construction site, a cost savings to all concerned. The facility should provide safe storage for the hard disk records that are accumulating too fast to store here at the Palace grounds. (Please abbreviate this new

Protective Disk Pavilion as the PDP. We must cut down on the mud-work!)

One suggestion that we think would help is to convert all procedures to the new documentation language that much of your industry is finding so useful—the Palestinian and Sumerian Common Arithmetic Logos (PASCAL). All new commands issuing from this Office will be formatted in this new code, and we suggest that you follow suit as soon as possible. However, please retain all old documentation in original form.

Yours Truly,
Royal D.O.D.

From: Babylonia-Assyria Building Erectors, Ltd.
To: Isis/Nile/Tutankhamen Enterprises, Ltd.
Kingdom of Egypt
Upper Nile
Ashurbanipal 2, Y.O.R. 7
Re: New Components
Dear I.N.T.E.L.:

We have read with interest your catalog of new devices and feel that the new miniaturized Inscribed Coptic tablets (that you designate "chips," appropriately) would be of immediate use in our ongoing Ziggurat Project. Please send us samples of these IC chips, and please send a sales engineer.

Yours truly,
Ahshugar, Chief Engineer
B.A.B.E.L.

P.S. Hurry!

From: Royal Department of Development
To: Babylonia-Assyria Building Erectors, Ltd.
Euphrates 9, Y.O.R. 8
Re: Schedule Compliance

For some reason, on-site inspection reveals that progress on the fifth tier is lagging dangerously behind schedule. Some of the foremen have been heard threatening to quit. Please remind them of the severe penalties for early withdrawal. We have retained outside consultants to audit your documentation and to make recommendations for schedule compliance.

In preparation for the field visit by the Investigative Expert Euphratean Engineers consultants, please reformat all new documents into their standard language, Logical Instructions for Specifying Pyramids (LISP). The IEEE consultants will arrive within two weeks. Please make accommodation to store their records in the new PDP data base.

Yours truly,
Royal D.O.D.

From: Investigative Expert Euphratean Engineers
To: Royal Department of Development
Copy to: Babylonia-Assyria Building Erectors, Ltd.
Baal 24, Y.O.R. 8
Re: Documentation Audit of Tower of Babylonia-Assyria Building Erectors, Ltd.
Royal Sirs:

Our two months of investigation show an incredible lack of information management by the Babylonia-Assyria Building Erectors, Ltd. Sloppy calculations, wasted funds, and an unbelievable system of duplicated records. Why, their data base alone is nearly as large

as the Ziggurat! (May we add, also, that the stacks of hard discs seem slightly unstable and in the upcoming rainy season, because of the crayfish burrows within the data base, the entire structure may become an actual public danger, should the disks crash.)

We recommend a complete overhaul of the project management immediately, especially in the data processing and information handling areas. Strangely, it seems that five more tiers have been completed since we began this audit. (Some say, in jest, this is because we interrupted the flow of information.)

Yours truly,
I.E.E.E.

From: Akkadian Tablet & Transport Co.
Babylon Office
To: Babylonia-Assyria Building Erectors, Ltd.
Re: Data Transmission from Tiers of the Ziggurat
Baal 32, Y.O.R. 8
Dear Sirs:

At the request of the Royal Department of Development, we have surveyed your data-handling techniques at the Ziggurat, and have several recommendations to alleviate the problems. First, we propose that the hard disks be transmitted from each tier directly down to the adjoining stacks of the data base. This will eliminate the necessity of the slaves making trips up and down the tiers, and will relieve the crowding, allowing work crews to make more progress.

We call our proposed tablet transmission system the *T carrier system*. A long rope and pulley arrangement will transport packets of tablets down to the data base for storage. Our Long Lines engineers will install and operate this system, and we expect to see immediate improvement in your construction schedule as a result.

Furthermore, our development laboratories are reviewing your documentation requirements with an eye toward further simplification. Our software people have come up with a simplified version of the Chaldean used by the keepers of the King's harems. This new "C" language will operate very well on the new EUNUCHS system, developed by our subsidiary, Baal Labs.

Yours,
AT&T

From: Construction Engineering Office
Ziggurat Site
Babylon
To: Babylonia-Assyria Building Erectors, Ltd.
Babylon
Tigris 11, Y.O.R. 8
Re: PERT Schedule Progress

Boss, these new data transmissions systems put in by Baal have turned the trick! We're on the twentieth tier now, and only ten to go! If there were only a way to cut down even further on the mud-work, we could even get back on schedule. (I am still a little concerned about our data base—it's higher than the Tower now, and not nearly as stable. Some of the earlier disks near the bottom show signs of extreme compression and I'm not sure they'll be readable when they are retrieved. Just a thought; probably not to worry.)

By the way, some tech reps from a new company, the New Ionian Papyrus

Promoters of Nineveh, dropped by the site yesterday. I sent them on to you guys. Looks like they might have a few improvements in software to sell.

Yours truly,
Ahshugar, Chief Engineer

From: New Ionian Papyrus Promoters Of Nineveh, Inc.
Nineveh Import Headquarters, Inc.
Nineveh
To: Babylonia-Assyria Building Erectors, Ltd.
Marduk 9, Y.O.R. 9
Re: Proposed Software Improvements
Dear Sirs:

N.I.P.P.O.N., Inc. is happy to offer you a new dimension in software—data recording and storage on papyrus, a thin, flexible medium that weighs little and costs less than your current hardware and hard disks. These "mini-floppies" will revolutionize your documentation flow. Please let us set up a demonstration at your earliest convenience.

Politely yours,
N.I.P.P.O.N.

From: Chief Engineer
Construction Site, B.A.B.E.L. Tower
Babylon
To: Babylonia-Assyria Building Erectors, Ltd.
Babylon
Marduk 34, Y.O.R. 9
Re: N.I.P.P.O.N. Software

Hey, Boss! This is incredible—those guys from Ionian really know their stuff! The mini-floppy disks allow the scribes to put sixteens of more marks on the same area. Why, in food alone we are saving a bundle. I mean, it used to take three meals a day for one scribe to scratch out three hard disks. Now he can do about twelve in one day. Using the old standard of eight bites = one meal, we can estimate that we're getting at least four times the number of bites of information that we used to get. In all, considering the number of scribes on site, we're up to several kilobites per hour—quite an improvement!

(By the way, though, the mini-floppies have caused a few problems. They are harder to stack than the old hard disks, and keep blowing away. I have arranged for them to to be stored in chests for protection against the wind. The crew has started calling them "Wind Chesters." At least the data base won't be growing quite so tall anymore.)

Yours truly,
Ahshugar, Chief Engineer

From: Foreign Competition Commission
Division of the Royal
Department of Development
Palace, Babylon
To: Babylonia-Assyria Building Erectors, Ltd.
Babylon
Ashurbanipal 2, Y.O.R. 9
Re: Compliance with FCC regulations
Dear Sirs:

It has been called to our attention that your company, the Babylonia-Assyria Building Erectors, Ltd., and some of its subcontractors may be guilty of illegal and uncompetitive business practices in connection with the Ziggurat Project.

Complaints have been received from local slave unions that monopolistic practices and the importation of foreign nationals have been causing enormous

layoffs of slaves in the last year. Be it noted that the Contract specifically requires that local slaves be utilized fully before offshore slaves can be imported. Also, the Organization of Euphrates Manufacturers (OEM) have reported massive imports of foreign hardware for use in the Project. Tablet 438 of the FCC regulations prohibits imports of hand-held calculators and personal computers on Royal projects, unless local OEMs cannot provide the equivalent devices.

The FCC inspectors will be on the Ziggurat construction site one month from today. Please have all of your records, both copies, on hand for on-site audit by investigative authorities, and in chronological order.

Yours truly,
F.C.C.

From: Chief Engineer
Construction Site
To: Babylonia-Assyria Building Erectors, Ltd.
Re: FCC Investigation
Ashurbanipal 17, Y.O.R. 9

Help, Boss! I'm in a bind! There's no way I can get rid of these foreigners in only one month! Besides that, how am I supposed to hide all of our computing equipment that we purchased from offshore? I mean, ever since I started using that new Abacus-Derived Algorithm (ADA), life has been a breeze! And every engineer on site has some version of these foreign personal computers—a Tyre Research Scriber-80, an Assyrian Papyrus Printable Legible Enscriber, or a Persian Encodable Tablet—and they're not about to give them up. We will try to do our best however. But stall as long as possible!

(And, Boss, how in the name of Ashurbanipal am I supposed to arrange our records in chronological order? All of the earliest stuff is on the bottom! It will be a major effort to turn that data base around without a crash. And the rainy reason starts next week . . .)

Worriedly,
Ahshugar, etc.

From: Foreign Builder Investigation
HQ, Babylon
To: Babylonia-Assyria Building Erectors, Ltd.
Offshore Office
Knossos, Crete
Re: Extradition of Criminal
Baal 11, Y.O.R. 9
Dear Sirs:

His Royal Majesty, King Nebuchadnezzar, requests the immediate return to Babylon of your Chief Engineer, one Ahshugar, to stand trial for last week's fiasco in downtown Babylon. H.R.M. believes that the culprit responsible should be given all fair rights and then be slowly impaled as befits criminals.

Agents of the F.B.I. have trailed Chief Engineer Ahshugar to Knossos but have been unable to persuade him to return. He is protected by some irrational malcontents from his construction crew. He must be returned to Babylon, where, as you know, the Ziggurat project terminated in unseemly fashion during the FCC investigation.

The Chaldean Government will lodge a protest unless this incompetent is returned forthwith!

Yours truly,
F.B.I.

* * *

From: Asugard, Chief Engineer-in-Exile
Oslo Village
Vikingland

To: Babylonia-Assyria Building Erectors, Ltd.
Offshore Office
Knossos, Crete

Re: Extradition Request and Banishment

Baal 29, Y.O.R. 10

Hey Boss! It was all a mistake! When that FCC crew came to the site, they started messing with the data base. The inverted pyramid of chronological disks was higher than the Tower, you know, and with the rainy weather and the instability of the disks, we just had a disk crash of major proportions. I'm sorry that it knocked down the top half of the Ziggurat, but that's life, you know. And the FCC did it, not me!

And even they admit that much, right? As for the other part, well, it was just a reaction to the three years of data processing and storage I had had to endure. (I am glad that you were visiting the offshore office. Lucky!)

I know they got really mad, and I am really sorry about what I said. I didn't mean to call it "the biggest number crunch in History"! Really! ■

Space Transportation: YOU CAN GET THERE FROM HERE!

Gordon R. Woodcock

There is an old shaggy-dog story that tells of a lost tourist who questions a local resident about the way to where he wants to go. The local is not sure; after struggling with directions, he tells the tourist, "Well, son, you just can't get there from here." This is what space flight enthusiasts have been hearing from the skeptics ever since the first proposals for spaceships. The reason is the same: The skeptics don't know how to "get there from here" and think no one else does, either.

In the beginning, the early rocket and space flight scientists, like Konstantin Tsiolkovskii in Russia and Robert Goddard in the U.S., were accused by some of their contemporaries of getting carried away with enthusiasm for rocketing into space. It was commonly believed, even in scientific circles, that rockets "pushed on the air" and wouldn't work at all in space. Further, there was conservation of energy: A rocket using ordinary fuels must exceed its own jet velocity to reach orbit and this was thought to violate that basic physical law (it doesn't). The message was, "You can't get there from here." These skeptics, as is often the case, operated on intuition instead of analysis; intuition is less trouble. Basic rocket theory, of course, has changed little from Goddard's day.

The problems involved in designing and building ships to reach space were greatly underestimated by the early enthusiasts; the skeptics would likely have been right for a long time had it not been for German developments in the Second World War. The German experimenters' work attracted the attention of their military and became well-funded and secret. The German rocket team, led by Wernher von Braun, developed (among other things) the V-2 rocket. It was the first manmade thing to actually reach space, although it only reached about 1/5 of orbital velocity.

By the end of the Second World War, the military potentials of long-range rockets armed with nuclear warheads were undeniable. Still, there were skeptics. In 1947 Vannevar Bush remarked on the impossibility of the "high-angle rocket" (ICBM) because he thought

neither the precision inertial guidance nor the re-entry heating problem could be solved. (In other words, you can't find your way there, and if you could, you can't get back.) Within a few years, of course, these problems *were* solved and serious ICBM development began.

By 1950 the space enthusiasts were impatient to get on with *real* space flight. In 1953 von Braun published a series of articles for *Colliers* magazine proposing a large rocket ship to launch and assemble a manned orbiting space station. Although the public loved his stuff, von Braun's technical contemporaries were appalled. They couldn't even get one rocket engine to run right, and Wernher wanted to cluster fifty of them! Jonathan Leonard described one of von Braun's critics of that period: "Dr. (Milton) Rosen is not an emotional man, but his face turns white with horror as he talks about difficulties that von Braun passes over as gaily as if they did not exist. . . ." (Anyone who thinks he knows how to get there from here is some kind of nut!)

Once begun, space flight developed rapidly. Only eight years after the von Braun articles in *Colliers*, President John F. Kennedy set the U.S. program on a course for the Moon. The skeptics were heard from, of course. Thomas Gold, a British astronomer, speculated that the Moon was covered by seas of dust into which the Apollo ships would sink, never again to be seen. (If you *do* get there from here, you will be sorry!)

Space flight evolved from artillery rockets. The progression from the V-2 to Apollo-Saturn was a very rapid scale-up in size and sophistication, but not a change in concept. And the very large artillery was very expensive! An all-up launch cost about half a billion dollars. To reduce cost, we conceived the idea of the space shuttle. A major revolution in space rocket systems, the shuttle will bring back a lot of the high-priced hardware to be used over and over. The term "space transportation" was coined to describe this new way of going to space.

Most of our space dollars have been going into shuttle development since about 1974. Except for the spectacular flights of the Voyagers to Jupiter and Saturn and the Vikings to Mars, it's been pretty quiet on the space-flight front since then. There has been, however, a quiet revolution in thinking about future space missions. In 1972, as the shuttle was being planned, its uses were forecast as very much "more of the same," spacecraft like those of 1972 but maybe a little larger. Now, as the first flight of the shuttle has successfully taken place, we are entertaining bold and imaginative thoughts of large communications platforms, zero-g manufacturing plants, satellite power stations, mining the Moon and asteroids, and human colonies in space. The most ambitious of these projects would have thousands to millions of people living and working in space. Are these ideas realistic? When? The skeptics say, "You can't get there from here because you can't afford it!" Indeed, *affording it* is the big issue. What advances in space transportation are needed? Are they in the cards? When? Tough questions. Let's look first at what we need and then at what can be done to "get there from here."

One technology is already a vigorously growing commercial activity. This is communications; the technology has already come of age. Arthur C. Clarke conceived the geosynchronous communications satellite in 1947, but thought commercial application of the idea to be so far in the future that he didn't even try to patent it!

The cost of space communications is already so low that there is a substantial market. Several generations of communications satellites have been launched. The latest, Intelsat V, will provide about 13,400 voice and two TV circuits each.

The comsat makers are now thinking bigger—five to fifteen tonnes of satellite and someday much more. Reducing the cost of space transportation is not as important as more "throw weight" and improvements in switching technology. The big comsats of the future will offer some remarkable services. Let's take a look:

Chris closed the door behind him, thinking of the cold beer that awaited in the fridge. On his way to the kitchen he said to his videocom, "What's the news?" He glanced at the displayed headlines and went to get his beer. Returning, he said, "Number four." Instantly, two paragraphs of a news story flashed on the screen. Chris spoke again, "Let's see the rest of it!" The videocom reacted somewhat woodenly, "Cannot translate last request." Chris articulated more carefully: "Entire story—hard copy, please." The machine responded dutifully, and Chris sat down to read the news story. To the machine, again, he said, "Music." Noting the ready sign, he continued, "Rachmaninoff." Again the machine balked. Chris muttered "damn" and got another message on the screen requesting interpretation. He went to the keyboard and typed the composer's name. Quickly a list of available recordings appeared. Saying "twelve" over his shoulder, Chris returned to his chair, his news story, and his beer.

High above the Earth, the Infosat began scanning a holographic memory; a digital data stream was encoded on Chris's assigned channel. (The same memory was being scanned at different points for many other users who had requested the same work.) In Chris's apartment, his videocom decoded the data stream into quad stereo. Nearly noiseless and distortion-free music filled the room. "Beats the hell out of rummaging through a record collection," Chris mumbled as he turned the page of the news story. Later, he would watch TV and call his brother overseas, all through the videocom-satellite network.

By the year 2000, spoken communications with computers in everyday language was commonplace. The best systems could carry on reasonably eloquent conversations, but this required lots of memory, speed, and software. Chris's low-cost system had a vocabulary of a few hundred words, enough so that use of the keyboard was infrequent, but his system was hardly a stimulating conversationalist. Linked together by satellite communications, all the world's computer power was available at Chris's fingertips—for a suitable service charge.

* * *

Today, capital investment in space communications is more than a billion dollars. There is a lot of room for growth—ground-based communications assets far exceed $100 billion and there is little doubt that space communications assets will approach this figure by the end of this century.

As more capital becomes tied up in space assets, a need for manned support services in space will develop. "House calls" in orbit will become important. It is terribly frustrating to know that one's expensive spacecraft is simply out of reach if something goes wrong—especially if it's something simple like the fuses that have recently blown on the Solar Max spacecraft, nearly wiping out that mission! A few dollars' worth of parts have literally raised havoc with a $75-million mission. A way to "get there from here" for maintenance and repair will reduce costs as well as frustration. This, not science, will be the motivation for a permanent human presence in space.

Manufacturing in space is beginning to develop as a further commercial potential. For years, manufacturing engineers have been intrigued by the special commodities of space: limitless high vacuum and zero gravity. Vacuums can, of course, be created here on Earth but at considerable expense. The vacuum in space can be much better than those created here. Zero g cannot be maintained on Earth at any price.

Experiments on the Skylab and Apollo-Soyuz missions showed some of the promise of zero-g processing. One popular idea—ball bearings—is pointless since excellent ball bearings can be made cheaply on Earth, but other products: special crystals and glasses and certain pharmaceuticals have real potential. Commercial ventures in these areas are just beginning. Even exploratory ventures require the routine access to space that only the shuttle can provide.

Successful products will need space factories for production. These will be relatively automated to reduce costs. Frequent human service at a space processing factory, however, would be essential to its operation. A space station will orbit near the automated factory. The crew won't bother the manufacturing environment in their day-to-day living and they will be close at hand when they are needed.

Reduced space transportation costs would really stimulate this marketplace. A tenfold reduction in cost (below shuttle) could lead to a hundredfold increase in space traffic for this purpose. Items produced in space would become a part of our lives, as has space communications. And we would recognize "space worker" as a real occupation.

More ambitious space projects will demand dramatic improvements in space transportation beyond the space shuttle. One such is construction of solar power stations in space to beam electric power to Earth for commercial use. The beaming of enough power to fly a small helicopter was demonstrated about fifteen years ago by Bill Brown of Raytheon. Power beaming—using microwave radio frequencies—could be scaled up to deliver thousands of megawatts of electric power on each beam over the distance from geosynchronous orbit to

Earth. The possibility of such a scale-up was conceived by Peter Glaser in 1968. Such *Solar Power Satellites* could operate day and night without interference from weather. The idea has been under serious study by the U.S. Department of Energy and NASA.

The skeptics have chimed in, as usual: "You can't get there from here because space transportation costs too much!" The power stations are admittedly a tall order. Each one would need hundreds of rocket flights to lift its 35,000 to 50,000 tonnes to orbit. Several hundred people would work in space assembling the fifty-square-kilometer satellites. For these power stations to be economic, the cost of space transportation must be no more than $20 to $40 per kilogram, a factor of twenty or more below anticipated shuttle costs.

Although the power station project strains credulity, it is by no means the most ambitious idea around. Space mines for resources to be used either on Earth or in space, as well as large permanent human settlements in space, have been proposed. The finiteness of Earth's resources has been widely advertised; "Limits to Growth" is a modern buzzphrase. The usual message is that civilization is doomed (or at least in for some hard times). With today's oil prices, one is inclined to listen to this stuff. Space enthusiasts, however, claim that "Limits to Growth" is an Earth-centered view. Moon and asteroid mines, as well as space farms, are visualized as ways to go when Earth's resources can no longer suffice.

Products from space mines and farms, however, may not stand the cost of space transportation. Most bulk commodities traded on Earth are worth less than $1 per kg: ores, common metals, foodstuffs, fuels (OPEC oil, even at today's price of some $40/barrel, is only about 30¢ per kg.) For a commodity to be economic, its transportation cost has to be a lot less than its market value. Although an easily mineable lunar source of precious metals (none is known) could be profitably exploited at shuttle costs, supplying the Earth with industrial raw materials would demand transportation costs less than $1 per kg.

Special raw materials may become much more valuable than $1 per kg because of scarcity and lack of substitutes. An example is chromium: essential for production of high-temperature, corrosion-resistant alloys, it presently comes from South Africa. The only other known high-grade ores are in the Soviet Union. Chromium is present in lunar soils at about 1000 parts per million. We haven't found high-grade ores, but we haven't looked very hard. Someday we will check out the lunar "mascons," areas of unusually high density. Lunar mascons create gravitational anomalies; they gave the Apollo orbital mechanicians fits until computer routines were modified to include mascon effects.

It might be better to take the people to the resources—perhaps much less costly than taking the resources to the people. Contemporary thinking about space settlements has been pioneered by G.K. (Gerry) O'Neill of Princeton. There are worries about the cost and about who will pay the bill, but space settlements are at least within technical reach. As Tsiolkovskii said over fifty

years ago, "The Earth is the cradle of human civilization, but one cannot live in the cradle forever."

We are at a sort of halfway point. The earliest space launches cost roughly $1 million per kilo. The shuttle will probably bring this to something like $1000 per kilo. We would like to get below $1 per kilo. How *do* we get there from here? Where do current trends and new ideas lead? How far can we get by improving what we're doing now? What are the potentials of the radical concepts proposed by the more visionary space enthusiasts?

Let's begin with the risks of making forecasts—even a cursory look at the history of technical forecasting reveals a spotty record. In 1910, for example, astronomer W.H. Pickering wrote, "The popular mind often pictures gigantic flying machines speeding across the Atlantic carrying innumerable passengers in a way analogous to our modern steamships . . . it seems safe to say that such ideas are wholly visionary, and even if a machine could get across with one or two passengers, the expense would be prohibitive to any but the capitalist who could use his own yacht." However silly this may seem today, it was respected scientific opinion in 1910. Transoceanic air service, of course, began in the 1930s, without any technical breakthroughs unforeseeable in 1910. Synergistic improvements in engines, aerodynamics, and structural design led to machines like the China Clippers. "A little bit here and a little bit there," and we were flying airplanes with capabilities not foreseen by simple extrapolation.

Let's look at some of the schemes space transportation designers are hatching to "get there from here." We have already, of course, reached interesting places, so it is not hard to appreciate that most of the new ideas have to do with reducing costs.

The presently high cost of space transportation suggests that we are not really very clever. The energy of a payload in low Earth orbit (compared to that at rest on Earth) is only about 9.3 kWh per kilo, worth some 50¢ to $1 per kilo at today's retail electrical energy cost. Shuttle transportation costs will be a thousand times greater, and the shuttle is to be "cheap" compared to its predecessors. We must be doing something wrong!

In fact we are, and it is no secret. As long ago as 1972, Ted Taylor wrote, "There is no fundamental reason why space transportation costs into and back from high Earth orbits should not become as low as, or even lower than, present costs of transportation by jet aircraft . . . present costs are several orders of magnitude higher . . . because they are roughly equivalent to the use of jet transport planes for carrying freight a distance of several thousand miles, making one flight every few weeks, throwing away the aircraft after each flight, and including the entire construction and operations costs of several airports in the costs of a few flights."

The shuttle, by its remarkably successful first flight in April 1981, has begun to fix these problems. Only part of the machine is thrown away on each flight—the expensive stuff is reused. Much more could be done. Estimates

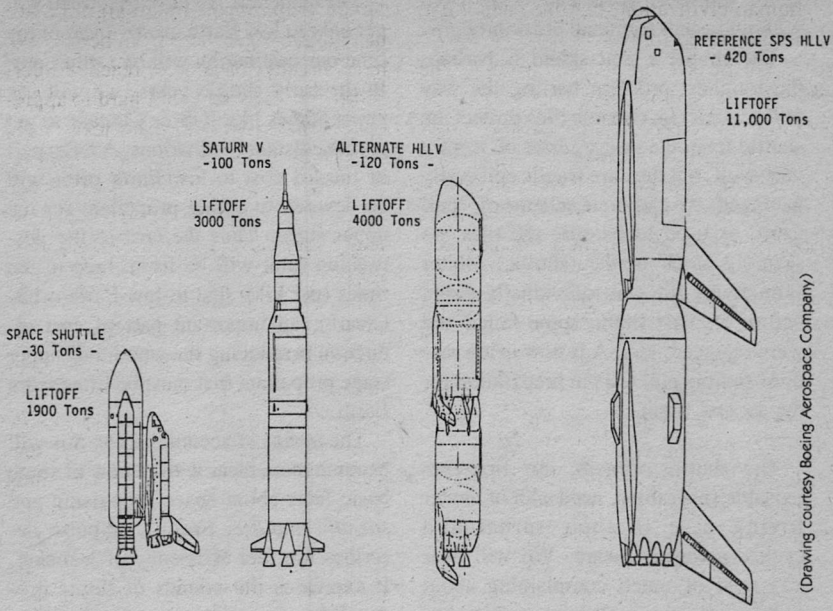


Figure 1. Two heavy-lift launch vehicle concepts are compared here with the space shuttle and with the Saturn V Apollo Moon Rocket. The "reference SPS" vehicle was reflected in the studies of the Solar Power Satellite for NASA and the Department of Energy. The "alternate" vehicle was also analyzed in the same studies and was later recommended as a more logical step after the shuttle.

for fully reusable launcher designs have projected costs 30 times cheaper than the shuttle—$30 per kilo compared to about $1000. These designs are called "heavy-lifters" because they are larger than the shuttle and would indeed lift heavy payloads. (Two such design concepts are compared with the shuttle and the Saturn-Apollo moon rocket in Figure 1.) As a passenger ship, the smaller of these "heavy-lifters" could carry several hundred people into orbit at a ticket price less than $10,000 each. At this price, it is not hard to imagine one or more hotel chains thinking of an orbiting casino or resort.

Such low-cost estimates are greeted by scoffs from the skeptics—"So much improvement over the shuttle is impossible!" Some of them even doubted the shuttle would work. Now they merely doubt it will work as advertised; there are dire predictions of long turnaround times and high cost. Like the improvements in airplanes from 1910 to the 1930s, however, great reductions in

space transport costs can occur even without further technical breakthroughs.

The shuttle's heat shield is perhaps the toughest problem barring the way to low costs. Its ceramic tiles protect the shuttle from the searing heat of reentry very well, but they are fragile and easily damaged. An elaborate scheme of "pull tests" is used to be sure the tiles are securely stuck to the (shuttle) orbiter skin. Every tile was individually tested before the first flight; some failed and were replaced. NASA is now using random-sample pull tests in preparation for the second flight.

The shuttle orbiters, our first-ever reusable spaceships, need a lot of tender loving care in their turnaround cycles—expensive care. We will hear and read of much complaining about problems in the next year or two, but it is a safe bet that what is difficult in 1981 will be routine by 1990. Another of Ted Taylor's problems was the meager traffic of space flight. It is at least ten thousand times less than today's air traffic. And here there is a sort of "Catch-22." Low cost needs high traffic. But who will demand the high traffic without low costs? Very likely, space communications and zero-g processing will provide the growth path, but today we cannot be sure.

Thirty dollars per kilo is not the best that might be achieved with conventional rockets. If space launchers flew at the same ratio of total cost to fuel cost as commercial jet aircraft do, they would sink to about $10 per kilo to low Earth orbit. Fuel costs alone preclude reaching $1 per kilo, but heavy industry in space could exist at $10 per kilo.

The launchers we have described will get only to low Earth orbit—most of the time our destination will be farther out. In the early shuttle years, we will use upper stages like IUS or Centaur to get to more distant destinations. A large part of the lift cost to low Earth orbit will be devoted to lifting propellant for the upper stage. Thus the cost to the destination orbit will be from three to ten times (per kilo) that to low Earth orbit. Clearly, an important part of cost reduction is reducing the amount of upper stage propellant that must be lifted from Earth.

The means of accomplishing this will become more clear with review of some basic facts about space propulsion and *specific impulse*. Specific impulse describes the fuel efficiency of a rocket. It expresses the pounds of thrust produced by one pound per second of propellant flow. Each engine on the shuttle orbiter, for example, produces 470,000 pounds of thrust and consumes 1,030 pounds of oxygen and hydrogen each second. The specific impulse is approximately 456 pounds thrust per pound mass per second, usually simply expressed as 456 seconds through the (improper) equivalencing of pounds mass and pounds force.

Conventional spaceships are propelled by rocket jets. The jet, of course, only lasts as long as its fuel lasts. We want to minimize fuel consumption and this means high specific impulse (high jet velocity). Twice the specific impulse, half the fuel consumption. We also need, of course, enough thrust. Unfortunately, the power in the jet is the velocity multiplied by the thrust.

High thrust at high specific impulse is the Holy Grail of space propulsion and is about as unattainable. Let's see why:

A conventional liquid rocket engine is ideal for high thrust with low weight. Its reaction products do not go through any machinery; instead, they go directly from the combustion chamber out the nozzle. They also carry away waste heat from the engine. Modern rocket engines develop well over 1000 hp per pound of weight. Compare this with a little better than one hp per pound for a racing auto engine and less than ten for a jet airliner engine. These engines, however remarkable their thrust-to-weight ratio, are limited in jet velocity by the energy content of their fuels; we already use the most energetic of practical fuels, hydrogen and oxygen.

We can easily get high specific impulse from a *power-limited* system like electric propulsion—any jet velocity up to lightspeed can be achieved. But the jet is produced by machinery rather than by a simple nozzle, and worse, the power cycle waste heat must be got rid of by huge radiator panels. Today's technology can only give us about 0.01 hp per pound of weight, 100,000 times less than liquid rocket engines, and foreseeable improvements are only going to improve this by about a factor of ten. At least a thousand would be needed before we could see electric propulsion as our "Holy Grail."

An electric propulsion system, of course, carries its power supply along wherever it goes. If we could leave the power supply behind, this would help quite a lot. Very long wires won't do the trick. But *power beaming* may be just the ticket. Electromagnetic waves will be used: microwaves, millimeter waves, or laser light. The feasible beaming distance is proportional to antenna size (or laser optics size) and inversely proportional to wavelength. Microwaves (10-15 cm) are too long for the powers and distances appropriate to space propulsion. Millimeter waves could serve for Earth to geosynchronous orbit and lasers could reach out to the Moon without too much difficulty (of course, no one has *yet* built a laser big enough).

Microwaves or millimeter waves would have to be converted to electricity to drive an electric propulsion system. Laser light can also be so used, but there is another way—the laser beam can be concentrated enough to directly heat a propellant. The laser rocket options are compared in Figure 2. The laser heater scheme will probably be limited to about 1500 seconds' specific impulse, but this is three times the jet velocity and ten times the jet energy of ordinary rocketry. The laser heater can probably produce enough thrust to be within shouting distance of our "Holy Grail."

What we really need is a way to use a high-energy reaction analogously to the ordinary (chemical) rocket. That is, a way of transferring the energy of the reaction to the jet without a lot of intervening machinery. If we need more energy than chemical, where to turn except nuclear?

Nuclear space propulsion began a couple of decades ago with development of the hydrogen-heater NERVA rocket engine. Since the hydrogen was heated by direct contact with the reactor, the specific impulse was limited by its melt-

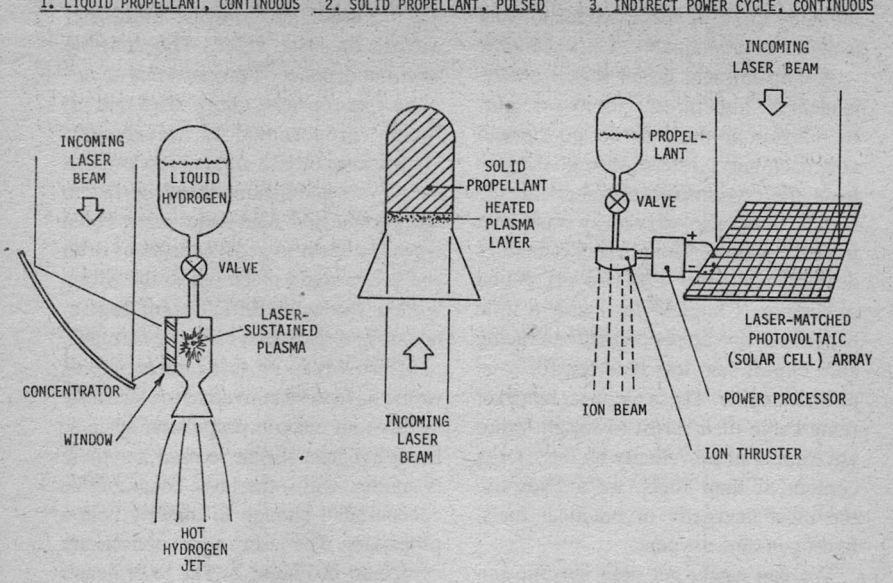


Figure 2. Laser power can be converted to heat or electricity. Either way, the energy can be used to produce thrust. Ignition of a plasma by either of the methods shown on the left requires higher laser intensity than does conversion to electricity. Consequently, the electric option would presumably not use the laser power as efficiently. Which means is best has not been ascertained.

ing point to about 800 seconds, but this is twice the best chemical rocket and hence four times the jet energy. The NERVA engines worked well in ground tests, but further development was cancelled in the early seventies for lack of a mission.

More ambitious nuclear engines have been conceived. Temperature limits of NERVA could be circumvented if the nuclear reaction could take place in a gaseous plasma. *Gas-core* nuclear rockets have been studied for years, but no one has figured out how to make this idea work well enough. More celebrated was the Orion concept, the "nuclear pulse" or bomb propulsion idea. Orion was an audacious idea, one that probably would have worked and would have delivered high specific impulse with high thrust. Orion foundered on the nuclear test ban treaty, which expressly prohibits flight testing of any machine powered by nuclear explosions. Further, Orion had so much potential capability that it made the decision-makers of the time nervous.

Fusion technology now offers the possibility of micro-explosions, using lasers or electron or ion beams to ignite small pellets of fusion fuels. (Micro-ex-

plosions within an apparatus are presumably not prohibited by the test ban treaty, which has to do with explosions of weapons.) Micro-explosions are called "inertial confinement" in the current fusion jargon. Together with magnetic confinement, they are being researched in the hope of developing practical fusion power and getting the world off its oil binge. If inertial confinement can be made to work in lightweight, long-life powerplants, these tiny fusion explosions will become *the* space connection: a propulsion system powerful enough to make touring the solar system convenient and routine. No more worrying about launch windows or delta V budgets; just point your ship where you want to go and *go*.

So far, we have talked only of propulsive systems, those that go by expelling a propellant. There are other ways: sails, towers, cables, and guns. These are all concepts that don't use propellant (at least not directly). Some of these schemes offer the potential to swap energy, with the eventual payoff of reducing space transportation costs below the limits dictated by energy costs.

Solar sails were proposed as long ago as the 1920s. Sunlight exerts pressure that can be used as thrust. The force is only about 2½ pounds per square mile at Earth's distance from the Sun, but no power equipment is needed, only a large lightweight reflector. The entire structure and reflector must be lighter than kitchen plastic film, but such exceptionally low masses are possible in space. A solar sail, of course, needs no fuel. Such ultralightweight systems cannot tolerate even the merest hint of a planetary atmosphere; they will be able to operate only between high orbits. Eric Drexler of MIT has proposed designs for solar sails suitable for flights to Mars or the asteroids. These "sunjammers" could conceivably someday provide very low-cost transport from Earth to Mars.

Of the various non-propulsive space transportation schemes, the simplest is the tower. Suppose we could build a tower from a point on Earth's equator all the way up to geosynchronous orbit. It would rotate with the Earth and its top would be at orbital speed at geosynchronous altitude, about 3 km/sec. An elevator could carry a payload up the tower, turn it loose, and it would be in geosynchronous orbit. If there were also a car coming down, it could "lift" the car coming up. (As the force of gravity isn't constant with height, we would need a way to store energy.) The only energy cost would be in the inefficiency of storage. Crazy? There have been serious papers on this subject.

Most of the papers have described the incredible strength of materials needed for the tower. When people built with stone and brick, construction was limited to tens of meters. With steel, hundreds of meters. What technology will get us to millions of meters? None we presently know. The strength required is at least ten times more than the best known materials. A tapered tower can reduce the needed strength, but the need is still far beyond known or foreseeable technology.

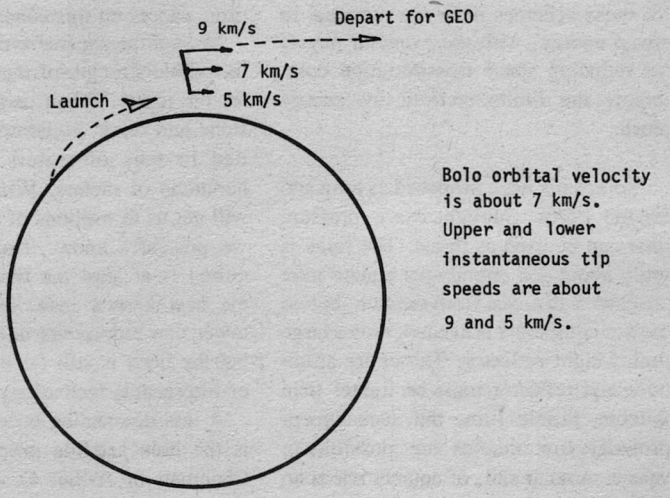
A less demanding energy exchanger is the bolo satellite proposed by Phil Chapman of Arthur D. Little. Chap-

man's bolo is comprised of two space stations tethered together by a cable about a thousand kilometers long. The bolo spins end-over-end along its orbit, as sketched in Figure 3. A launch vehicle can rendezvous with the lower end of the bolo as it sweeps nearest Earth. Latching on at that point, it is swept into orbit. The bolo spin rate is enough that the launcher can be 2 to 3 km/sec short of orbital velocity. This could reduce launch energy by more than 50%. The rendezvous is sporty, but probably not more so than hooking up aircraft for midair refueling.

The energy has to come from somewhere, of course. There is no such thing as a free lunch. If traffic is returning to Earth as well as departing, a bolo can exchange energy. Returning traffic is released at the same point of the bolo's arc that upcoming traffic is hooked on. If the upcoming and returning traffic are of equal mass, they trade energy and the bolo need not make up anything. If they are different, the bolo satellite must make the energy corrections, probably using electric propulsion.

There is more to this. If the bolo tips revolve at about 2.3 km/sec, anything released at the top of the bolo arc will coast to geosynchronous altitude in about five hours . . . another bolo there with tip speed about 1.4 km/sec could reel the "anything" in to that orbit. Even more, a ship released from the top of *this* bolo's arc will escape Earth's gravity entirely!

Figure 3. A bolo satellite station could make space transportation more efficient. The rotational velocity of the bolo tips subtracts from the velocity required for a launcher, and adds to orbital velocity for sending vehicles on to geosynchronous orbit. The bolo system is most efficient with two-way traffic.



Finally, since lunar orbit velocity is within the tip speed capability of a bolo, a lunar orbit bolo could reach down close to the lunar surface and land and pick up payloads without much propulsion at all.

The bolo concept is at a very preliminary state of analysis, and there are a number of unresolved issues. But it has enough promise to merit serious study when we begin to essay unconventional means of spaceflight.

Another non-propulsive idea that has been somewhat more thoroughly developed is the *space gun*. Jules Verne used a primitive (and unfeasible) gun concept in his story of a trip to the Moon written over a hundred years ago. Max Valier reviewed it in his early space flight text published about fifty years ago; Valier identified electromagnetic acceleration as a way to make a workable space gun. The concept has recently reappeared, called *mass driver*. This latter term is Gerry O'Neill's contribution; the mass driver figures prominently in his schemes for space colonies supported by consumption of lunar raw materials. Current research has shown that the mass driver will work. The secret is superconducting magnets; the earlier schemes without this feature surely would have failed.

Mass drivers could be used to launch raw materials from either the Moon or the Earth into space. The lunar application is simpler inasmuch as the required velocity is only about 2½ km/sec compared with 11 km/sec for Earth launch. Further, the Earth-launched projectiles must be protected from severe aerodynamic heating, but we now know how to do this. Launch accelerations would be thousands of g's, so not everything can go this route—certainly not human passengers! But for those things that can, the launch cost has been estimated at less than $5 per kg from Earth and a good deal less than that from the Moon.

There are some intriguing combinations of new concepts. One of the most promising (and very new) proposes the supply of lunar oxygen to low Earth orbit for use in conventional rocket upper stages. This idea employs mass drivers to get the lunar rocks to a stable lunar libration point and aerodynamic braking in Earth's upper atmosphere to ease the delivery of lunar-derived oxygen into low Earth orbit. The mission profile is sketched in Figure 4. The secret of this seemingly roundabout scheme is that 6/7 of the propellant used by a hydrogen-oxygen rocket is oxygen; hydrogen lifted from Earth has considerable leverage in obtaining oxygen from the Moon. The lunar crust is 60% oxygen; the payoff may be as high as a factor of three to five reduction in the mass that must be lifted from Earth to fuel an upper stage. This puts chemical propulsion about in the class with electric propulsion, but without the complications of low thrust. The lunar oxygen supply scheme, of course, involves a certain amount of overhead in Moon mines and space processing plants and would only have a net payoff when there is much more than today's space traffic.

We have surveyed quite a number of possibilities, and it is time to take stock. Surely all these concepts will not be developed. Which ones will? Where are

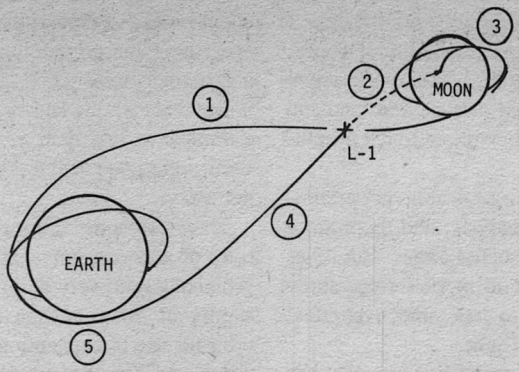


Figure 4. Oxygen may be provided to low Earth orbit from the Moon more cheaply than from Earth. (1) Lunar base provisions shipped from Earth. (2) Lunar rocks launched from the Moon to L-1 by mass driver. (3) L-1 base also supplied from Earth via lunar swingby. (4) Oxygen tankers return from L-1 to Earth. (5) Excess speed of returning tankers is killed off by aerobraking pass through upper atmosphere.

the real payoffs, and when? One who assays such guesses must recognize the risks of looking foolish in light of what actually develops, but here goes:

First, maturity of the shuttle will develop slowly. Success of the first flights are, of course, a big boost. There is already some hand-wringing about how it isn't going to (in the sense of routine operation) work as well as we had hoped. But after a few years of experience, and substantial expenditures for improvements, there will emerge a widespread realization that we have in hand a space transportation system of great economic potential. Significant steps toward commercialization of space transportation will begin by 1984.

The next major NASA program will be a shuttle-supported manned space station. Its timing hinges on some level of confidence in routine shuttle operations. The station will serve as a space terminal for the shuttle and will be used for upper-stage handling and spacecraft final assembly, only secondarily for science.

Before 1990 the shuttle will carry upper stages using hydrogen and oxygen, also electric propulsion. Improvements of the hydrogen-oxygen stage will begin with aerodynamic braking for return to Earth orbit. Later, lunar oxygen will be introduced, but only after much debate over its merits. Exploitation of lunar oxygen (and later, other resources) will bring about the beginnings of lunar settlements, but these will for a time be regarded as "bases." Longer and longer staytimes will devolve from the high cost of carrying people back and forth. Serious talk of "settlement" will begin when the first child is born on the Moon.

The next major U.S. development in

civil launch systems will be commercial and will occur before the year 2000. The potential operating profit in a system that can fly for about a tenth the cost of the shuttle will become irresistible to a commercial venturer when the requisite technology becomes available.

Eventually, fusion propulsion will open up the planets. The pace may be set not so much by technical feasibility as by gradual dissolution of the geocentric view (the Moon will be viewed as "part of the Earth"). But ultimately we will get nickel steels from the asteroids, hydrogen and organics from the outer planets' moons, and settle where we will. Mars will become the great frontier of the next century. With as much land area as Earth, a 24+ hour day, *some* water, and an atmosphere that only requires very creative "air conditioning" to make breathable, Mars will attract settlers when space transport costs get low enough.

Parallels between air transport and space transport are many. Air transport was about thirty years old before it really began to pay its way. And then it grew and grew and grew. To visualize space transport, say, in the year 2040, try this: Imagine you are watching a barnstormer flying a World War I Jenny in the mid-1920s. From *that* vantage point, try to conceive of today's great fleets of commercial jets that have captured nearly all long-distance passenger travel! ■

ABOUT THE AUTHOR

Gordy Woodcock was born and grew up in Oregon and was educated as an engineer. At an early age he was interested in space flight, astronomy, and science fiction; he can remember when publishing articles on space flight was considered by some professionals as a blight on one's professional image. In the late 1950s, when it was widely believed that the new frontier in space propulsion would be nuclear, he began an advanced degree in nuclear engineering, eventually granted in 1965. During this period he was employed by Boeing as a missile propulsion engineer. During the Apollo years (1963-1968), he worked for NASA in Huntsville in an advanced programs office and was involved in manned lunar and planetary missions studies. Those were the years when a manned Mars landing was seen as the next "big" mission, and most space planners believed it would be accomplished by 1985. After a brief but exciting stint working for Boeing in a support role to the Apollo Program Office in Washington, D.C., during the time of the first lunar landing, he returned to the west coast with Boeing. Since 1969 he has worked on a number of systems and systems studies including early space shuttle studies, overall space transportation, solar power satellites, and space stations. He is presently responsible for a study of the Space Operations Center concept.

● All my education, all my degrees and writings, have not taught me how to be courageous.

Hilbert Schenck

Janet Aulisio

P.E.

Michael P. Kube-McDowell

As a good teacher once said, "Nobody can teach you anything. The best I can do is to help you learn."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AUGSO
1982

"Let me simplify this discussion," snapped Robert Szabo. "Get—me—out!"

"You're not ready for a Transfer," his biotechnician insisted. "Let me put you in the program, get you the pre-Transfer counseling you need—"

"I want out now. This week."

"It's a mistake to make a snap decision like this," the biotech pleaded. "You've got to hold off until the pain you're feeling is gone, and you can look at the decision more objec—"

"My pain is my business. Your business is arranging body Transfers."

"Without counseling, you'll be vulnerable. You have to leave this body content—"

Szabo moved toward the door. "Where are you going?" the biotech demanded anxiously.

"Every biotech within a thousand klicks of here will honor a World Council contract," Szabo said calmly. "Some of them will even honor a patient's requests."

"I have your best interests at heart."

"Then arrange my Transfer. I can't stay here any longer."

The biotech sighed.

"Does that mean yes?" Szabo asked, his hand on the doorknob.

"Friday. Friday afternoon."

Szabo nodded, satisfied.

"If you'll schedule ten hours' counseling, which isn't enough but will help," added the biotech. "And let me participate in your goal-setting session."

It was little enough to ask. Any competent biotech would insist on at least a month of profiles and testing before doing a Transfer for a new patient. The four-day delay would seem interminable, but it was the best offer he would get. "Agreed."

His new name was Robert Wyatt.

He looked at the reflection in the mirror, fingering the growth of reddish hair on his upper lip. *First moustache,* he thought. *Or was there one on the original?*

Though he strained to remember, without the Memory Vault that most Transfers kept it was impossible. Too much living—ninety-seven years in three other bodies—and too strong a commitment to not looking back intervened.

But the question, and the fact that he tried to answer it, told him that this time was different. The first two lives he had left gracefully, at biological 53 and 57 years respectively, and he had come alive again excited about the future. Now he felt the weakness of his will, and wondered if his biotech had been right. But from his point of view, he'd had no choice—the tritium leak, and Becky—

"Time to get going," he told himself sternly, leaving the thought uncompleted. That was the pattern he had chosen for himself, a soberingly long time ago—keep nothing, not even his name. It was only necessary to have something he wanted to do. That goal would give his new life its shape.

But his goal this time had a quixotic flavor. Ostensibly the planet was governed by the elected World Council and their representative, the Viceroy, ensconced on the sea-going artificial island that served as a capital city. But of late, the World Council often—too often, in Wyatt's view—took its cue

from the Viceroy's appointed Council of the Future. The COF's seven experts, backed up by an awesome research team, provided the World Council with confidential projections of current trends, predictions of the impact of current proposals, and suggestions of ways out of current problems. It was their job to take the long view, and they presented their case so persuasively that it was beginning to seem as if the real power rested with them—that no proposal frowned on by a COF scenario could hope to survive.

That, Wyatt knew from experience—experience which had given him his goal. Wyatt intended to become one of the seven. The retirement of the social psychology expert three years hence would give him his opportunity. There was nothing high-minded about it. He was looking for a measure of revenge.

But there was much to be done in the meantime, and Wyatt turned to his first task.

It was time to find a school.

By reputation at least, Northland Academy was the top Western Hemisphere school for psychology. But, Wyatt decided, it must take a special eye to see why.

"Animal behavior complex, there," said Glen Thorpe, dean of the academy, as he pointed across the plaza. He gestured at the sculpture of water, plants, and padded seats in the center of the patterned-concrete plaza. "The fountains are popular with the younger students for field studies of mating rituals—at night, in pairs."

Wyatt smiled politely, bored.

They reentered the main building, a bland-faced, multistory monument. "That's about all I have to show you," Thorpe said. "Any reactions you'd like to share with me?"

"There've been a lot of changes since I was last in school," Wyatt said. As he realized what he had said, he winced inwardly. It was the kind of statement that complete pre-Transfer counseling would probably have kept him from making. Temporals—except for One-Lifers, who freely chose that status—resented, even hated, the transferees. Out of simple self-protection, Wyatt followed the practice of most of his kin and kept his true age to himself. But he would have to be more careful this time. He wasn't well enough prepared to avoid the comparisons and references that could betray him.

Thorpe wanted to know more. "What was the main tutoring technique?"

"Sympathetic neural stimulation. Pretty primitive, I suppose. It was just a little school." Think before you speak, Wyatt ordered himself.

Thorpe seemed satisfied. "We try to keep the best of the old and stay abreast of the new," he said, leading Wyatt down a bronze-walled corridor. "Some schools are afraid of change. We think it helps the students to have their routines disrupted every few months. Keeps their thinking flexible."

"There don't seem to be many students."

"It's just the time of day. Actually, we're over-enrolled by three students. Four, if that's not being too presumptuous. Are you ready to discuss a contract?"

Wyatt stopped walking. "Look,

Glen—say, you must have a 'Doctor' that goes with your name."

"Of course."

"Then I hope you won't mind if I use it. Down-home humility annoys me. Dr. Thorpe, this tour hasn't made me much wiser. I frankly don't have the background to know when to be impressed. So tell me the best feature of the academy, and don't oversell it, and then tell me the worst feature, and don't gloss it over."

Thorpe nodded understandingly. "The best—that's easy. The P.E. room."

"Have I seen it?"

"No, deliberately. We reserve it for registered—"

"I want to."

"I'd really prefer—"

"If I sign a contract, you'll relieve me of seventy-five thousand Council dollars a year. I'd like to see what I'm getting for it."

Thorpe sighed. "Very well."

Wyatt scanned the contents of the P.E. room a second time and shook his head. The jumble of images refused to coalesce in his mind—hanging walkways and cavelike tunnels dotted an enormous multihued pastiche of masonry. The structure overwhelmed the volume of the hundred-meter-square chamber.

Thorpe noted Wyatt's awestruck expression. "Put it in words," he urged.

Wyatt considered. "An amusement park funhouse with a tumor problem."

The dean laughed heartily and stepped over to a Vis-Wall next to the exit. "That's a new one," he said, using a stencil to add Wyatt's comment to a substantial list on the pressure-sensitive surface. Wyatt followed him and read the entry above his own: "An indoor Alps by a God who failed fractal geometry."

"P.E. has changed, too," Wyatt said, when Thorpe turned back to him. "It may be the fastest-changing field of education."

"We used to do a lot of group things—"

"There's still a little of that."

"And you say this is your school's best feature? I would have thought—"

"You can hardly evaluate it properly from here," Thorpe added quickly.

"Then let's go up—or in—or whatever the right word is for that thing."

"In," Thorpe said. He studied Wyatt, as if weighing the potential reaction to a refusal. "Very well. Wait here while I log us in."

There was an intercom near the doorway. Thorpe crossed the floor to it and tapped out a string of numbers. "We're ready," he said softly. "Robert Wyatt—two T's. Alert Kenny. It's his program. He'll want to observe. I'll be up there shortly. Arrange a short path."

Meanwhile, Wyatt had puzzled out the basic arrangement of the maze. There were three main towers underneath the vari-glass dome, the shortest some sixty meters tall and perhaps that wide at the base—it was difficult to tell. The Alps analogy was accurate. It was a rugged manmade landscape, with narrow ledges and walkways hanging precariously out from sheer faces. A plethora of bridges of varying designs and materials linked the towers together, and tunnels honeycombed their hearts. To add more discord to the convoluted ge-

ometry, the surfaces had been daubed with seven strident colors of paint.

"Let's go," Thorpe said, walking past, and Wyatt fell in behind him. He followed the younger man, or tried to, up the steep, narrow ledge that curled around the base of the nearest tower. But where Thorpe moved easily and confidently, Wyatt struggled and hesitated. In short order Thorpe was so far ahead that he was out of sight around the curve.

As the path leveled off, Wyatt hastened his steps, annoyed that the dean hadn't waited for him. He quickly came to a fork in the path—one option a steep stairway, the other a dimly lit tunnel descending into the heart of the tower. Thorpe was nowhere in sight on either.

Wyatt scowled. "Inconsiderate clown," he said aloud. Angry, he turned to go back.

The anger was replaced by shock. Like Thorpe, the path behind him had disappeared.

"Not impressed," Wyatt called out, his annoyance returning. For the maze to have movable sections was no great trick, though the seams for this particular one defied detection. Wyatt waited a moment, but there was no change. It was clear they wanted him to go on.

The tunnel seemed to promise a quicker exit from the room than the stairs, and Wyatt chose it on that basis. But instead of a way out, Wyatt came to a tiny side crypt with a padded floor. In it was a student, sitting cross-legged and contentedly reading.

"Excuse me," Wyatt said, his tone negating the polite words. "I need to know how to get out of here."

"I don't know," the student said without looking up.

"How can you not know?" Wyatt demanded. "Aren't you a student here?"

"Of course," the boy said, still intent on his book. "But it changes all the time. I haven't gotten out the same way twice yet. Kind of like it." The boy closed his book and set it aside. "You must not be a student, then."

"I'm visiting."

"I think I would have guessed it. You're a little old."

"You watch your—"

"For here, you would be. I'll bet you're even married."

"So what? And I'm not."

"Sounds like you're not sure," the student said, amused.

"You don't know the way out?" Wyatt asked, directing the discussion back to his immediate problem.

"I thought I said that."

"Then go back to your damned book," Wyatt said, turning to go back. The tunnel he had come through, like the ledge before it, was gone. "When did that happen?" he snapped.

The boy looked up and shrugged.

"High-quality students here," Wyatt sneered, and moved into the descending portion of the tunnel.

The walls and ceiling of the passage were dotted with thousands of tiny, intense lights, like stars as seen from space.

Like stars—

For a moment, Wyatt was back aboard *Alcestis,* impotently staring out the viewport at the disc of Earth and the starfield beyond. Only his name was Robert Szabo, and he was a thirty-five-year-old line supervisor for the Colson

Mining operation on the asteroid Vesta. On Earth, Rebecca was dying from a massive ingestion of tritium, and there was nothing Szabo/Wyatt could do to help her or speed *Alcestis*'s passage back to Earth.

Then the lights were gone, and he pushed the memory to the farthest available recess of his mind—though there wasn't room in the very back—

A tiring climb up a vertical shaft brought him, panting, to a large ledge with benches and a railing on the side of the second and largest tower. A young man was sitting on the railing facing the center of the room, his feet dangling out over the edge.

"Hello," called Wyatt.

As the young man turned to see who had spoken, Wyatt felt his legs grow weak beneath him. It was Eldon Ritchie, as he looked the last time Wyatt had seen him—no, it was only a student, a little older than the last one. *My eyes are playing tricks with time,* Wyatt thought, frightened. *They're looking at today and seeing yesterday's faces. I wish I had postponed Transfer.*

But he kept his face calm. "I'm a visitor," he said, "and I've gotten separated from my guide. Do you think you could help me get out of here?"

To Wyatt's surprise, the answer was, "Sure." The student swung his legs over the rail and stood. "I've got a three o'clock class, anyway. If we don't have to go too high, I can get you out and make my class, too."

"Go too high?"

"Once I ended up going to the top of all three towers before I made it out. Took four hours."

Wyatt found the sound of that unattractive, and stepped to the edge. "What about making my own path? If I went over the side here, I could just walk out."

The student clicked reprovingly. "Have you felt the walls? They're so slippery it'd be one step to the bottom and a broken leg. It isn't necessary, anyway. There's always a way out."

"Trust the man who knows the territory, they say. What's your name?"

"Tim. Yours?"

"Bob. Bob Wyatt."

Tim snapped his fingers. "There's someone looking for you. Ran into 'em up a few levels."

"Dr. Thorpe?" asked Wyatt eagerly. "Where was he?"

"No, a woman. I haven't seen her around here before. She said she was looking for a friend. You, I guess. She said to tell you Beth is looking for you."

Once, in a different body, Wyatt had sprinted up the 312 steps of a Japanese Shinto shrine. Only then had his heart pounded as it had suddenly begun to pound now. "What was her last name?"

"She didn't say. We can try to find her—"

"No!" Wyatt said, with more vehemence than he had intended to show. "No," he repeated, with more control. "I just want to get out of here."

"All right. Then follow me."

Wyatt exhaled deeply and tried to calm himself. "She can't still be alive—and she can't be here," he thought fiercely. Logic and probability dictated that both statements were true, but as he fell in behind the student Wyatt remained unconvinced.

* * *

"Not that way," Tim said sharply, standing at the bottom of the stairs. His voice was loud in the small chamber.

Wyatt stopped in midmotion, a few steps from a narrow passageway that also led out of the chamber. "Why not?"

"It's a gate."

"What do you mean?"

"If you go through it—trip it—it closes until someone comes through the other way."

"You mean only one person can get through."

"Right. We'll have to go up the stairs."

"Does this thing—gate—lead out?"

"Sometimes, but so do the stairs. If we just go up three levels—"

"But this leads out?"

"I told you—it's a gate—"

"I need to get out more than you do," Wyatt said, moving toward and into the opening. "Thanks and goodbye."

The panel which moved in place behind Wyatt was not substantial enough to muffle the angry shouts of his ex-companion.

The man behind the crystal desk had aged, to the point where Wyatt would have been unsure of his identity. But the famous crystal desk of Viceroy Byron Bennington was unmistakable. The sight of it and him in an inner chamber of the P.E. room brought on for Wyatt that tremulous kind of moment in which one begins to mistrust his sanity.

"Hello, Bob," said the Viceroy in his well-known, evenly modulated voice. "It's good to see you again."

With an act of will and reason, Wyatt shut down the voices of self-doubt. Turning, he set about to unravel the apparent contradiction. His fingers searched the wall for the door that had been there and must be there, but failed to find it.

Only slightly daunted, Wyatt began to circle the room and Bennington. *I start with the assumption you're not real,* he thought to himself. *A projection means projectors which can be found and beams which can be interfered with.* When he had completed a full circuit of the room without seeing Bennington and his desk flicker, he turned his attention to the ceiling.

At last, unable to detect on any surface the aperture of the projector he knew must be there, Wyatt stepped slowly toward the Viceroy. He reached out with one hand for the surface of the desk, with the other for the Viceroy's wrist. Both were firm under his touch; the desk was cool, the flesh warm.

"Are you all right, Bob?" the Viceroy asked, still watching him with interest, but without editorializing.

Wyatt drew in a deep breath. "You can't be here."

"I never knew you to contradict the obvious."

"It didn't contradict good sense the way it does now. If you are here—and I don't concede it—why?"

"We have an appointment, of course—I asked you to come see me. I wanted to break it to you personally—the bad news about your proposals, that is. They've shredded them, the Council has, left only the whitening bones."

Despite himself, Wyatt slipped back forty years. It was easy—the time had been close to his mind. He was Robert Cittadine, director of the Office of

Technology Distribution—and the man he stood before had selected him for that job.

"I know," he said softly. "I got it from the rumor mill this morning. Is there anything left?"

"Scarcely. The ag development of the Brazilian Federation—I thought it showed such subtle understanding. Completely canceled. CanAmerica will lose the ChildMinder capsule."

"That's already in distribution!"

"Pulling it back. It's the same with all the rest. I'm sorry, Bob. I know how much time you've put in on those plans."

"And on the research," Cittadine/Szabo/Wyatt said bitterly. "The ChildMinder was my own work."

"Was it? How creative of you—I got more than I expected when I took you on."

"What reasons did they give? Or will I get an official report?"

"This *is* the official report—all there'll be of one. And you know the reason. They didn't like what they saw in the COF report on your proposals."

Cittadine/Szabo/Wyatt's face tightened. "I've been evaluating and introducing new technologies for almost fifteen years, and society hasn't crumbled. You set up the Council of the Future six months ago—and now you're listening to them over me?"

"We've come to realize that fifteen years is too short a perspective. Some programs already underway are going to have to be pulled back, now that we've taken a longer look."

"Don't they think *I* look ahead? What do they see that I don't? Is the World Council so sure of them?"

"I'm afraid we are, Bob."

"You, too." Cittadine/Szabo/Wyatt shook his head. "Can't you at least find out why? I've got to know what they're thinking. I can't work like this."

"I know why. It's that I can't discuss it. Future scenarios are highly confidential. In the wrong hands—of course, we trust *you*. But it would set a dangerous precedent." The Viceroy smiled winningly. "Thank you for coming by, Bob. I appreciate having the chance to talk with you."

"I'll bet you did," Wyatt said softly as the Viceroy turned to his Data-Tap unit. Air moved against the back of Wyatt's neck. He turned to see the passageway open again. As he took a tentative step toward it, the Viceroy called after him.

"Don't you see, Bob?" he asked. "You're here because of that time, those feelings—and so am I. You quit a few months later, and transferred. In your next life you ended up off-planet because you couldn't stand to hear about us every day.

"You're trying to make up for something that happened to you *two* lives ago. That must tell you that you're making a mistake."

"I'm the only one who can judge that," was the stony reply.

"Let Bob Cittadine be, and do something for Bob Wyatt," Bennington implored. "We were always friends. I wouldn't give you bad advice. As long as you keep chasing the past—"

Wyatt could listen no longer, and fled the chamber. He had nurtured anger inside him like a flame protected from the breeze. Now it had escaped his control. Moreover, he was confused that Ben-

nington had recognized him in his new body, and frightened by the prospect that more of his past stood in the way of his leaving the cursed maze.

Someone was ahead of him on the path, and trying to stay there. A flash of movement, hurried footsteps in a passage—Wyatt hastened his own steps, hoping for explanations, an exit, or both.

When at last Wyatt caught a clear glimpse of his quarry, he sighed, relieved. "Tim!" he called. "Wait!"

The figure ahead stopped and turned, and Wyatt's mouth went dry. It was not Tim. Just as Wyatt had once mistaken the student for Eldon Ritchie, now he had done the reverse.

Eldon Ritchie, who had walked out on a friendship the way some people walk out on a marriage. No word, and never look back. A friend made three lives ago, when Wyatt was Bob Garrett and truly young: the years that, to many, represent the way life should always be. Wyatt, the engineer, and Ritchie, the astrophysicist, were brought together by the vagaries of freshman dorm assignments at Michigan State. The friendship became strong enough to take them together to Purdue for graduate work. But twenty years later, the friendship ended—on a sunny afternoon that would otherwise have been a high point in Wyatt's memories.

After fifteen years in industry and five back in the university milieu, Wyatt at last had completed some truly original work. While investigating high-energy phenomena known as transient interference fields, he evolved a generator which would produce more stable, low-energy fields—and still render electrical devices inert. But as the partygoers —coworkers and close friends —brainstormed possible uses in a loud and lurid alcohol-assisted session, Ritchie quietly left. He went directly to the Space Science Office and changed his status to "Available." Two weeks later he was a resident on the SSO's orbital station. A month more, and he was en route to the new ob station in Pluto's orbit. Wyatt pursued him with calls and letters; Ritchie refused the former and ignored the latter. In time Wyatt gave up.

Now they stood face to face.

"*Doctor* Robert Garrett. An *extreme* pleasure," Ritchie said sardonically, "to meet someone who has done *so* much for all of us."

"I had hoped that if I saw you again, you might remember more than that last day."

"Are you still proud of giving the Viceroy your device—that damned Interruptor?"

"Yes. It—and he—put an end to world conflict. Why shouldn't I be proud?"

"Then nothing has changed." He shook his head unhappily. "After five years in close quarters with you, I knew how you thought. I knew where you were headed with the T.I. generators, almost before you did. If you never understood why I left—I didn't want to be around when it happened. I just couldn't get far enough away or stay there long enough. I'm still ashamed to have been your friend. Though I understand you better now."

"Oh?"

"Oh, yes. It's even been given a name. The Mortality Crisis. If you can

amass enough money in your first life, you can afford the body transfers that postpone death. But when someone sees the years pass and knows they're not going to make it, they panic—trading their good judgment, their values, those they love, in exchange for a few more breaths. I've made quite a study of it since getting back. You're not the only one. In fact, only the Church of the One Life seems to be immune."

"You don't understand at all," Wyatt said harshly. "You haven't the wit." He brushed past Ritchie and continued down the passage.

"Robert!" Ritchie called after him. "Don't be disappointed. Perhaps you and Elizabeth will get on better."

Wyatt turned and stared.

Ritchie smiled, self-satisfied. "She's here—waiting for you at the top. She's looking forward to seeing you." He laughed unkindly. "I'd like a reserved seat for that one."

"It isn't going to happen," Wyatt snapped. As much as he disbelieved in Bennington and, now, Ritchie, he found himself unable to stop himself from treating them as though they were who they purported to be. Somehow, they knew too much.

He had no desire at all to have the same thing happen with the former Elizabeth Garrett, his first wife.

But the maze, in Wyatt's conception becoming almost sentient, seemed to have other ideas. Suddenly the only paths available were upward; the only people visible, on other towers. Wyatt climbed reluctantly, looking for a chance to change direction. The chance did not come.

The path moved from the face of the tower to its interior. After a few steps he heard a bell ringing somewhere ahead of him. Shortly he came to a phone hanging on the right-hand wall. He passed it by, resisting the habit-rooted urge to pick it up.

The passage switched back and began to descend, to Wyatt's delight. The sound of the phone faded behind him, then stopped. Almost immediately the same sound came rolling up the passage from below. The path switched back again, and the ringing grew louder.

Wyatt was almost running when he passed the second phone. The air was cooler and Wyatt was certain he was nearing the bottom. His optimism dissolved as he rounded a corner and came upon a solid wall—and another phone, which began to ring.

Panting slightly, he picked up the receiver.

"Robert?"

"Yes."

"Robert, this is Hail'm N'gura. I thought you would wish to know—the device works. Have you taken note of the news?"

"No—I've been . . . preoccupied." Wyatt swallowed, remembering. He had received this call once before. It had been two days since he had watched Eldon board the deep-space probe; five days since Elizabeth had come by for the last of her clothes and the first of her temporary Income Adjustment checks.

"There have been field tests of the device. A Russian fighter crashed. A Chinese ICBM failed to function. In a short time, we will have enough Interruptors, and the World Council will be

a reality. There are no words to thank you. But I have arranged for you to be Transferred when the time comes, or you so choose. All fees will be paid by the World Council.''

It's an oddity of English that the same words are used when someone tells you they've indefinitely extended your life as are used when they hold open your door. ''Thank you,'' said Wyatt, and the passageway opened.

It had narrowed to a crawlway, but Wyatt went on.

He had gone ten meters into it when he heard a burst of electronic static. ''Earth transmission for you, Szabo. We'll put it through to your compartment.''

''No!'' Wyatt cried, remembering. ''No!''

''Mr. Szabo, this is Dr. Chen at the Stanford Radiation Clinic. As you have probably already guessed by the fact of my call, I have some unfortunate news.''

''Stop,'' Wyatt pleaded, almost whimpering. But there were no lines for him in this scene. *Alcestis* had been too far from Earth for a dialog.

''It looks now as though your wife's exposure was nearer to 200 REMs, an extremely high dose, considering the source. We performed a bone-marrow transplant, which seemed to work for a while. But blood cell production fell off drastically late yesterday afternoon. What would have been a touch of flu—she had it when she was brought in—became a massive infection. Becky did not survive the night.

''I know how you must be feeling—''

''Enough!'' Wyatt shrieked. ''Leave —me—be!'' he shouted, punctuating each word by pounding his fists against the unyielding floor.

But by the time he was finished, it was already silent in the crawlway. As it had been before, the message was too ugly, too abrupt, and left him with nothing but his pain.

Wyatt looked out across the bridge to the main tower it led to and the serpentine path that wound to its top.

''What if I just stayed here?'' he asked bitterly. ''Would you send her down to me?'' He started across the bobbing rope span, then stopped, looking at the truncated pinnacle of the tower. ''I don't even know that you're there, do I? I only have the word of a phantasm for that.''

His legs heavy with reluctance, Wyatt climbed.

For a moment on reaching the top, Wyatt thought he was alone. Then, from a lookout alcove to his right, someone stepped into view. At the first instant of motion, Wyatt turned to retreat.

''Why, Robert—don't you want to see me?''

''No,'' he said. ''I don't.'' *She can't be here,* he thought fiercely.

''That's nice—a little guilt after all. Something you said you'd never feel.''

''I still don't,'' he said, facing her. He was unprepared for what he saw. Age had taken most of what he had known. Her face was so deeply lined as to be almost unrecognizable, and the sight destroyed the memory he had been protecting. He averted his eyes.

''Those of us without friends or money age,'' she said coldly. ''Aside from my appearance, has the world turned out the way you hoped it would?''

"It doesn't matter whether it has or hasn't. I did what I thought was right."

"Yes—an honorable tradition. I believe all traitors say that at some point."

"I'm no traitor," he said, looking up.

"Oh? Is there a new word? You gave N'gura what he needed to make his little world government possible. Now they sit out in the Atlantic with their floating city and make the decisions for us. My country—*your* country—is nothing. It's even lost its name."

"Nation-states were dying out. The Interruptor just cut the suffering short. The multinationals, common markets, regional planning—look there for your blame, if you must."

"You're not a damned historian! You lived there; you were one of us. How could you watch what happened and not feel—so much was lost—"

"And more was gained."

"By you," she snapped, her voice rising. "You got what you wanted. You had your choice—you could have had me, or taken care of yourself. You chose yourself."

"That's not the choice I was making! It was between a chance for a benevolent, peaceful—"

"You can't sell that high-minded crap to me, Robert. Just tell me this—have you been happier than you would have been with me? Have your three or five or twenty bodies given you as much love as I would have? Have all your great accomplishments left you any more fulfilled?"

"You didn't have to leave," Wyatt said, his voice tight. "*I* decided to help N'gura. *You* decided to leave."

"I'm not surprised that you've twisted it so that in your mind I'm to blame. But when you made your choice, you knew what I would do. You know, I'll bet you even enjoy seeing me this way. It's your final victory, isn't it? I'm going to die, and you're going to live forever."

"Elizabeth!" Wyatt was stunned by the depth of her bitterness.

"When I think of you these days, I remember something you told me when we barely knew each other," she went on. "You said that because your mother had her dance career, you didn't get to see her very much. I always thought you had said it with resentment. Now I see how it set the pattern for your life. She put her needs over yours, and I don't think you ever forgave her for it."

"Shut up," Wyatt said threateningly.

"You're still trying to punish her through us," she screeched. "Look at what you did to Becky—leaving her alone, to die alone. Look at what you did to me. If it isn't enough yet, come on! It should be easier for you than it was sixty years ago—because now I look old enough to *be* your mother!"

Wyatt lunged toward her, pushed beyond the limits of his self-control. His hands reached out for her throat, his only thought to silence her.

A moment later he was lying stunned on the floor. His hands had passed through Becky without resistance, and he fell forward through the dissolving image. And from his crumpled form arose a barely human wail of despair.

The Glen Thorpe who then appeared was real. He led, and a pair of students helped, the traumatized Wyatt to a reassuringly ordinary office, beyond but adjacent to the maze.

There Thorpe gave Wyatt what he appeared to need most: time to think. Thorpe waited patiently while Wyatt struggled to focus his gaze and his thoughts. Presently he looked up from the floor and silently sought Thorpe's attention. The defenses which had been such a prominent part of his demeanor—arrogance, pride, self-importance—were gone.

"I haven't left any of it behind, have I," Wyatt said slowly. "It's all still with me."

Thorpe nodded. "Yes. The emotional baggage of three fairly turbulent lives."

"Because I passed up pre-Transfer counseling."

"No. That was only a symptom. Because of the Transfers themselves."

That seemed to puzzle Wyatt, but his capacity for puzzlement had been exhausted. What could not be integrated he freely ignored. "But I'm better now, is that it?"

"No. Just more aware." Thorpe spoke firmly, but soothingly. "I don't believe in catharsis. You have a lot of work ahead of you." He leaned forward in his chair. "But when you're finished that work, I'll help you reach your goal. By then I hope you'll have a less selfish reason for wanting it."

Wyatt regarded Thorpe suspiciously, as if the dean were about to introduce unwanted complications into his carefully constructed but fragile schema. "What reason is that?"

"What reason do you have now? You were a clever inventor—a master at using existing technology in novel ways. Through one of your inventions, you've even helped change the world more than most people get a chance to—though to be honest, the histories will credit N'gura and leave you as a footnote. In any event, some of your best inventions—the ChildMinder among them—exist only in your head and Bennington's archives, because his Council of the Future forbade their introduction. You took that very personally—especially when they wouldn't tell you why they did it. As if they didn't know who you were, and what you'd done! Right so far?"

"If you know enough to do to me what you did in that hell, you don't need an answer." It was the old Wyatt's words, but they came out flat, false, lacking fire.

"True enough." Thorpe looked away for a moment. "I do know that this is where you began to lose touch. You could hardly expect the World Council not to take the long view. You see, most of them expect to be here for some time."

Thorpe stood up and walked to the 400-liter aquarium set at eye level in the far wall. "No, it's quite an admirable thing they're trying to do with the Council of the Future. It's a long-overdue idea." He turned back toward Wyatt. "But they've made a mistake. There's one extremely dangerous technology that they have not even considered withdrawing—one whose effects are not theoretical."

"Transfer technology," said Wyatt, with sudden insight. "Maybe—maybe Eldon and Elizabeth were right. Maybe I did know what the Interruptor would mean for me."

"The Mortality Crisis is real, and you were a victim," Thorpe agreed. "But there's more." He waited.

"It changed the way I thought," Wyatt said at last. "What I thought was important. People who were temporals were less important—what they had to say less valuable. They were annoyances. They could be ignored, because they'd go away, in time." He closed his eyes and slowly shook his head. "Oh, Becky," he said softly.

"Call it the Eternity Complex. The class thinking; us versus them. The supercilious manner, the unreasoning conservatism, the misoneism. The concentration of power—political and financial—in a few long-lived individuals. Those who are temporals don't see it. Those who are transferees *can't* see it. There needs to be someone on the Council of the Future who understands. Someone who can show them their mistake.

"Don't you see? It all comes together in you."

"No, I don't. Where do you fit in?"

"When the World Council went buying brain power to set up the Transfer conditioning regimen, I was one of those selected. When I asked questions they did not want to deal with, I was paid off and sent home."

"Why not you, then? You already have the credentials—and the motivation."

"Several reasons. Kellogg—the social psychology chair, the one you hope to replace—headed that study team. He would surely veto my selection." Thorpe frowned. "And because I know these things in an academic way only. I'm a temporal—a One-Lifer."

"Why do you care, then?"

"Because I have a sense of history. And because I have children. My sur-

rogate immortality, if you will. No—it must be you.''

Wyatt nodded—acknowledgement, but not yet assent. ''Now that I know why, can I see how?''

''Certainly.''

Thorpe led Wyatt to a large, brightly lit, circular room. Eight students sat at consoles around an enormous map—a three-dimensional computer holo. Thin blue lines marked the tunnels, walks, and ramps. Dotted orange traced the movable barriers and switches. Numbered red crosses marked the position of each subject.

''We started immediately after you called for an appointment,'' said Thorpe. ''Had you been a lesser light, I couldn't have gotten enough data in time.''

''Is it really called the P.E. room, or was that just to mislead me?''

''Call it a useful coincidence. P.E., to someone of your era, of course, means Physical Education. To myself and the staff, P.E. means Psychological Education. We use this facility to train students to deal with all kinds of personalities and situations—and to face the reality of their own psyches. But to a new student, P.E. is Personal Environment—an interesting place to relax, or be with friends, or be alone. Little by little we intensify the experience. In time, they come over to this side and learn how to use it.''

''And the people I saw?''

''Advanced students wearing sophisticated makeup, for the most part. Some were holograms synthesized by the computer from photographs.''

Wyatt watched as a student tapped out a code number on his console. The map changed size and perspective to show the routes available to a particular individual. ''I guess I know why you're proud of it, now.''

''We threw our best at you. It was important to reach you.'' After a moment's pause, he added, ''Did we?''

''Don't you know that answer, too?''

''I'm not a determinist. The choice is yours.''

Wyatt dropped his gaze and smiled uncertainly. ''I'll be staying. And if I can, I'll bring your message to the Council.''

''I'm glad.''

''Glen—''

''Yes?''

''One more thing?''

''Certainly.''

''You never got around to telling me the worst feature of the academy.''

Dr. Thorpe smiled. ''That's easy, too. Class is never dismissed.'' ■

● A society where the simple many obey the few seers can live: a society where all were seers could live even more fully. But a society where the mass is still simple and the seers are no longer attended to can achieve only superficiality, baseness, ugliness, and in the end extinction. On or back we must go; to stay here is death.

C.S. Lewis

Jay Kay Klein's biolog

Illustrator Janet Aulisio shares many of the features that have distinguished the best of *Analog*'s artists. For one thing, she loves science fiction for itself. For another, she is herself highly literate and a voracious reader. And then there is her determination always to do the best work she can.

A native of Hackensack, New Jersey, Janet studied first at the Phoenix School of Design in New York City for two years. The courses tended to be deliberately "practical," to prepare one for making a living in the "harsh" world of illustration. She decided that there ought to be more to life than simply trying to make a living, and switched to the Ridgewood School of Art in Ridgewood, New Jersey, where she received two years of instruction in fine arts. There were hours and hours of figure drawing and painting, with a stress on fundamentals. What Janet thinks she learned most of all, though, was to have patience with your art, to get it right and to expect that your style will evolve as you grow in skill and insight.

During this period she worked at a Hackensack bookstore with three floors of second-hand books. There she started collecting beautifully illustrated books, and would dearly love to combine art—by illustrating such volumes—with handling them in a small specialty bookstore of her own.

Her first professional assignment was for *Analog*, to do the interior illustrations for an Orson Scott Card story in the May 1978 issue. She had heard horror stories of flint-hearted art directors and indifferent editors, but has yet to find them in the science fiction field, where she prefers to work. For interior *Analog* illustrations, she uses good, rich India ink, creating form with stipples, line, and crosshatch, and solid areas of black. In this, influence comes from Albrecht Dürer, Howard Pyle, and Aubrey Beardsley, among others. Color covers for paperbacks include one for Kevin O'Donnell, Jr.'s *Caverns*.

In content, Janet tries to show the human element and people's relation to an oftentimes shocking or unfamiliar environment. She collects every article she can on space, but she's not nearly as much interested in the machines of the future as in the persons who will be operating them. Fallible and believable characters interest her the most.

For each assignment, she reads the complete manuscript. "I love to read (I cringe when I hear than infamous line 'I hate to read') so it is very easy for me to read through a whole book before beginning work," she says. "I know sometimes an artist will work from a synopsis, but I've seen the results of that and sometimes it misses too much. Though I'm allowed almost total freedom in my concepts, I don't feel an artist should take absolute license in interpretation. The author's words should be a guide for the artist so that the artwork will become part of the story and not separate from it."

When the American Cultural Center in Paris exhibited a retrospective view of American science fiction art, it chose illustrations by Richard Powers, Mike Hinge, Ron Walotsky, and Janet Aulisio.

Janet Aulisio

The Alternate View

NO OFFENSE INTENDED?

G. Harry Stine

"Space shouldn't be used for military purposes. Space exploration should be for peaceful purposes only. The NASA space shuttle must not be used for military purposes. Space should be a place where warfare doesn't exist!"

In a paraphrase, this is the party line of the anti-military space advocates.

Let's take an alternate view:

"Space is the only place where war ought to be waged."

Wars are going to continue to be fought as long as two human groups can find something to disagree about. Warfare is the result of diplomacy and politics that fail for a number of reasons. War is conducted because somebody believes there's something to be gained thereby. Ergo: the human race will continue to fight wars.

Warfare is getting to be too destructive to be fought on Earth.

Therefore, warfare should be conducted in space in order to protect the people on Earth and to preserve a peaceful way of life on Earth.

Like it or not, this is exactly what's happening—and not because the United States of America instigated it! Space has been used for military purposes since 1957 by the U.S.A., the USSR, the PRC, and to a lesser extent Great Britain, France, and Japan.

Who developed and launched the first intercontinental ballistic missile? Answer: The USSR, with the Korolev R.7 "Semyorka."

Who developed the first orbital weapon system? Answer: The USSR, with its Fractional Orbital Bombardment System (FOBS).

Who lost control of a nuclear-powered ocean surveillance satellite that fortunately landed in an unpopulated region of Canada? Answer: The USSR, with Cosmos 954 in 1978.

Who's launched and operated two manned military space stations? Answer: The USSR, with Salyuts 3 and 5.

Who has an antisatellite (ASAT) battle station in orbit as this is written? Answer: The USSR, with Cosmos 1,267 docked to Salyut 6 since June 16, 1981, and armed with clusters of meter-long satellite killer vehicles.

This last is good, hard intelligence data, and it bothers a lot of people, including me. Cosmos 1,267 is capable of attacking and destroying any other satellite in low-Earth orbit. This includes the SDS polar defense comsats used for high-priority messages such as transmittal of the SAC "go codes," the TRANSIT navigational satellites, the DMSP defense metsats, the Big Bird recon satellites, and the NASA Space Shuttle OV-102 *Columbia*.

Since the Cosmos 1,267 orbital battle station is docked to Salyut 6, the Soviets possess a manned orbital station for directing ASAT attacks against U.S.

spacecraft or to protect USSR spacecraft against the new U.S. air-launched ASAT.

Using a larger launch vehicle, the USSR could place an ASAT battle station in geosynchronous Earth orbit to threaten U.S. comsats—which now handle more than two-thirds of the world's long-distance communications—as well as U.S. missile early warning satellites.

Insofar as the anti-war space movement goes, it's too little and too late. Astronautics is following in the footsteps of aviation, where the initial military use of the new capability was for non-aggressive scouting, reconnaissance, and surveillance. As with aviation, somebody took a gun aloft one day, and the non-aggressive aspect of the arena suddenly changed.

However, as with maritime and aviation activities, the military services don't have exclusive use of the activity. There are far more commercial ocean-going ships and far more passenger and cargo aircraft than there are military vehicles in either arena.

And, as a matter of fact, military capability in a transportation mode is an absolute requirement for the conduct of peaceful commercial enterprises.

Americans should have learned this 180 years ago. In 1801 the United States had no standing army to speak of and no navy at all. Americans were a peace-loving commercial people. Fighting wars was nonsense and a waste of good time, effort, and money. (It still is.) Article I, Section 8 of the Constitution of the United States of America specifically grants Congress the power to "grant letters of marque and reprisal" which are commissions for privateers to conduct naval warfare, this being thought a cost-cutting shortcut eliminating the need for naval forces. Americans would rather trade than raid. Others didn't think this way. President Jefferson had to fight a war against the Barbary States to keep them from attacking American ships, seizing cargos, and ransoming sailors. It took four years and gave birth to the U.S. Navy.

Military forts in the American West a century ago were put there at the insistence of commercial interests so that the U.S. Army could defend the trade routes (overland trails), not as much against Indian raids as against outlaws.

Air superiority and airspace control over the United States permit the conduct of commercial and general aviation. It wouldn't be possible for me or this magazine's editor to engage in general aviation pursuits unless somebody knew that the airspace approaches to the U.S.A. were under surveillance, targets were spotted and known, and fighter planes were capable of intercepting unknown targets. Yes, hundreds of drug-runners penetrate the southern Air Defense Identification Zone (ADIZ) all the time, but NORAD knows they're there. AWACS and Pave Paws and other radars track these drug-runners daily. The airspace approaches to the U.S.A. may appear to an unaware layman to be wide open, but just try to breach an ADIZ without a filed flight plan! You'll discover you have an escort of two F-15 Eagles, one off your right wing while his buddy sits on your tail.

One factor that's consistent throughout history is continuity. Humans modify known and working systems to meet

the new factors of a new activity. And space is definitely a human activity that exhibits all the continuity of past human activities. This includes a military presence. Space cannot be a non-war area until humans stop fighting, and they won't stop fighting until every human being accepts and lives by a new philosophy or moral code which doesn't include fighting and warfare as operational elements. This may come to pass in the next century or so as we perfect Arthur Clarke's universal nervous system of mankind, the communications satellite network and all its consequences (which include winning H.G. Wells's race between education and catastrophe). Until then, nobody in his right mind will risk putting money and effort into space factories, solar power satellites, or space colonies unless they're protected against the Attilas who still roam the world and the space around it.

If I've hocked my wife's jewelry and mortgaged myself to the hilt to build anything on the ground or in space, I'm either going to set up a paramilitary defense force to keep some two-bit Attila from taking it away from me by coercive force of any sort; spread the cost of such a defensive force between myself and several of my colleagues by hiring Brinks or Purolator; or take advantage of the protection my taxes are paying for anyway in the form of the United States Department of Defense.

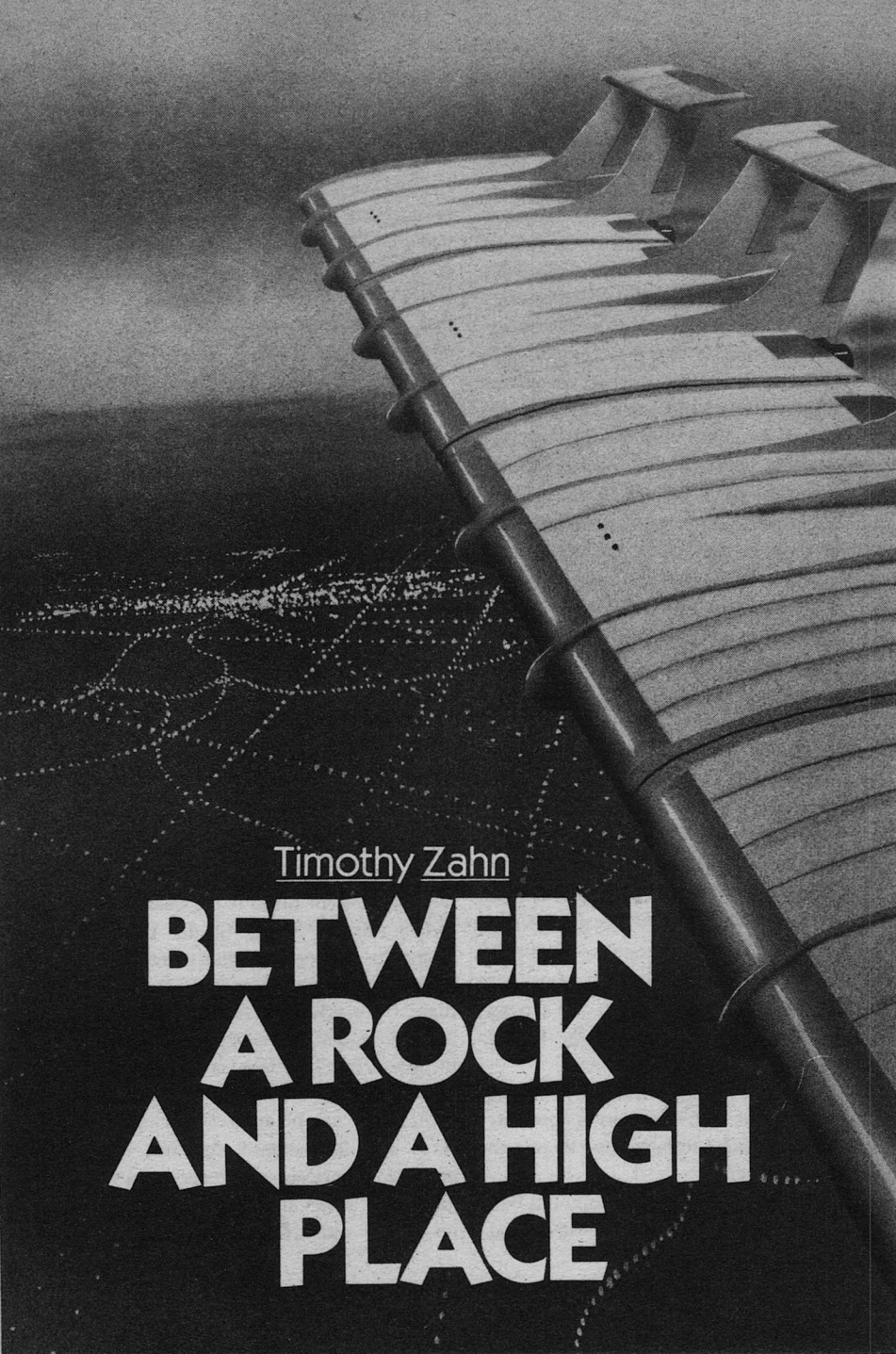
This is especially true when things like Cosmos 1,267 are staring down my throat. I'd want to make sure there's no offense taken!

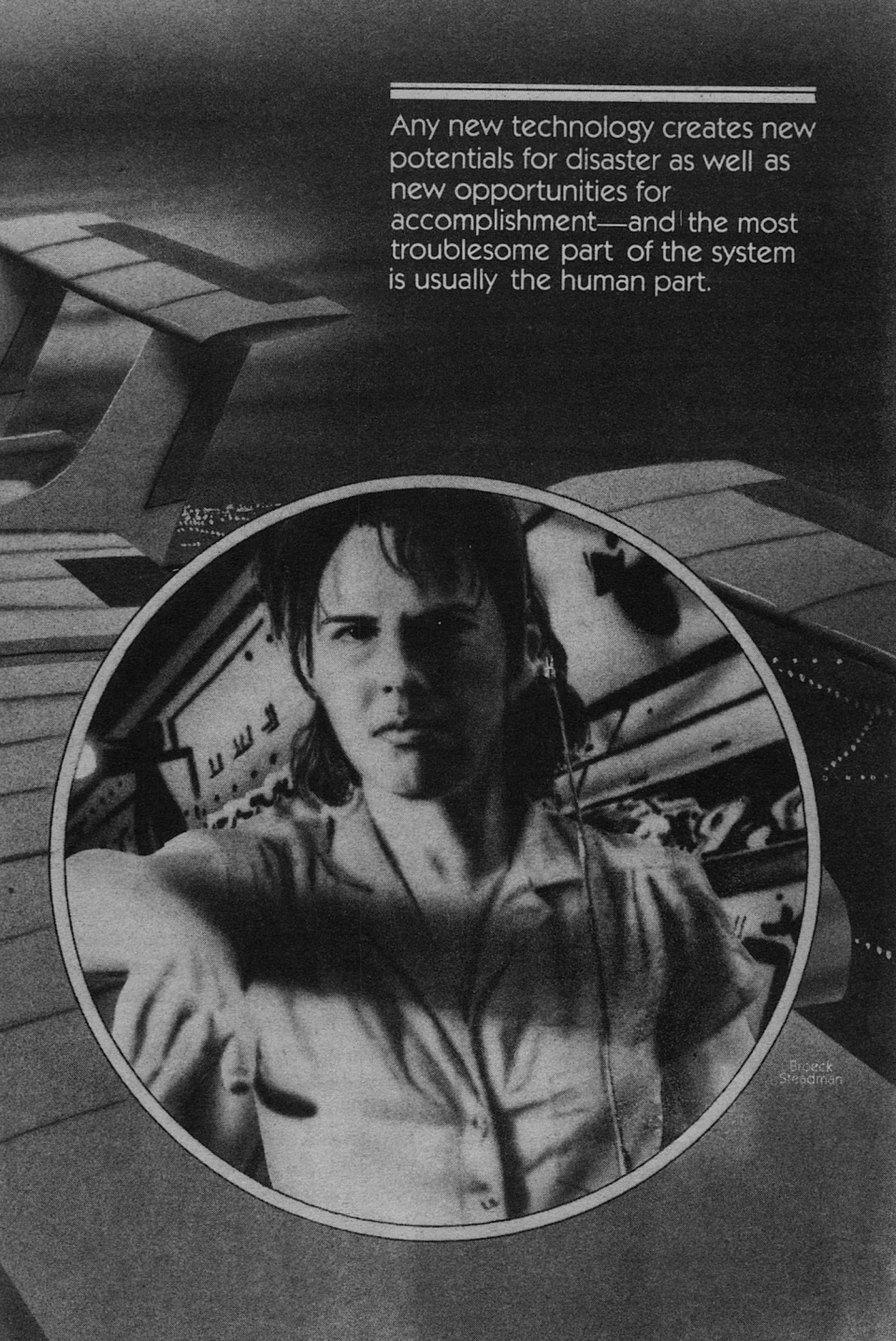
Somebody is certain to point out that places like Andorra, Liechtenstein, and Switzerland haven't been invaded in recent times. In the case of Switzerland, nobody wanted to upset a beautiful banking situation where one could stash the loot, to say nothing of the fact that Switzerland would be very costly to invade, conquer, and occupy; Caesar discovered that. In other cases, the places weren't worth the trouble because they had no particular strategic or tactical advantages.

There may well be Andorras, San Marinos, Liechtensteins, Switzerlands, and Hong Kongs in space. But they aren't there yet. And they won't be established by treaty or formal agreement any more than their Earthly counterparts were; they'll just happen because it's convenient and they're needed.

In the meantime, it's nice to have the cavalry ready to come to the rescue.

The current United States space policy, such as it is, appears to be based on this. I don't like war and I don't like to fight. But I'm glad there are people who do, and I'm willing to pay for police and military forces to deter violence, crime, and war. In the United States, there's little possibility that the military will take over space, for several reasons. One of these is the basic historical military policy of the United States that places the military under civilian control. The other is the fact that there's considerable feedback within our system that prevents military domination. That feedback is anti-militarism. As long as *neither* gains total control, we can be assured of that elusive, hard-to-maintain, dynamic balance the American system seems to be capable of achieving. And there will be no offense taken. ■


Timothy Zahn
BETWEEN A ROCK AND A HIGH PLACE


Any new technology creates new potentials for disaster as well as new opportunities for accomplishment—and the most troublesome part of the system is usually the human part.
Broeck Steadman

"Ladies and gentlemen, shuttles one and two for United Flight 1103 are now ready for general boarding: Skyport service from Houston to Dallas-Ft. Worth, Los Angeles, and San Francisco."

Peter Whitney was ready; he'd been standing at the proper end of the waiting lounge for the past several minutes, as a matter of fact, eagerly awaiting the announcement. Picking up his carry-on bag, he stepped to the opening door, flashed his boarding pass for the attendant's inspection, and walked down the short tunnel to where the shuttle waited. The excitement within him seemed to increase with every step, a fact that embarrassed him a little—a twenty-eight-year-old computer specialist shouldn't be feeling like a kid on his first trip to Disney World, after all. But he refused to worry too much about it. Professional solemnity was still, for him, a recent acquisition, easily tucked out of the way.

The shuttle itself was unimpressive, of course: little more than a Boeing 727 with a heavily modified interior. Following the flight attendant's instructions he sat down in the front row, choosing the left-hand window seat. Pushing his bag into the compartment under his chair, he fastened his lap/shoulder belt and spent the next few minutes examining the ski lift-style bars connecting his pair of seats to the conveyors behind the grooves in floor and ceiling. He'd seen specs and models for the system back in St. Louis, but had never given up being amazed that it worked as well as it did in actual practice.

His seatmate turned out to be a smartly-suited businesswoman type who promptly pulled out her *Wall Street Journal* and buried herself in it. A bored executive who flew in Skyports every week, obviously, and her indifference helped dispel Whitney's last twinges of guilt at having taken the window seat.

Within a very few minutes the shuttle was loaded and ready. The door was closed, the tunnel withdrawn, and soon they were at the edge of the runway, waiting permission to take off. Whitney kept an eye on his watch with some interest—Skyport logistics being what they were, a shuttle couldn't afford to be very late in getting off the ground. Even knowing that, he was impressed when the plane roared down the runway and into the sky only twelve seconds behind schedule.

They turned east, heading into the early-morning sun to meet the Skyport as it headed toward them from its New Orleans pickup. Whitney watched the city disappear behind them, and then shifted his gaze forward, wondering how far away something the size of a Skyport could be seen. Docking, he knew, would take place seventy to eighty miles out from Houston; assuming the shuttle was flying its normal four-ninety knots—five-sixty-odd miles an hour—meant an eight to nine minute trip. They'd covered seven of that already; surely they must be coming up on it by now. Unless . . .

With smooth abruptness, the horizon dropped below the level of his window, and Whitney knew he'd goofed. The Skyport was somewhere off to the shuttle's right, and the smaller craft was now circling around to get into docking position. Belatedly he realized he should

have asked the flight attendant which was the scenic side when he first boarded.

The passengers on the other side of the aisle were beginning to take an interest in the view out their windows, and Whitney craned his neck in an effort to see. Nothing but ground and sky were visible from where he sat; but even as he settled back in mild disappointment the shuttle leveled out and began to climb . . . and suddenly, ahead and above them, the Skyport loomed into view.

No film clip, scale model, or blueprint, Whitney realized in that moment, could ever fully prepare one for the sheer impact of a Skyport's presence. A giant flying wing, the size of seven football fields laid end to end, the Skyport looked like nothing else in aviation history—looked like nothing, in fact, that had any business being up in the air in the first place. The fact that it also flew more efficiently than anything else in the sky seemed almost like a footnote in comparison, though it was of course the economic justification for the six Skyports now in service and McDonnell Douglas's main argument in their ongoing sales campaign. Staying aloft for weeks or months at a time, the Skyports were designed for maximum efficiency at high altitudes and speeds, dispensing with the heavy landing gear, noise suppressors, and high-lift flaps required on normal jetliners. And with very little time spent on the ground amid contaminants like dust and insects, the Skyports had finally been able to take advantage of the well-known theories of laminar flow control, enabling the huge craft to fly with less than half the drag of planes with a fraction of their capacity. In Whitney's personal view, it was probably this incredible fuel efficiency that had finally convinced United and TWA to take a chance on the idea.

The shuttle was directly behind the Skyport now and closing swiftly. From his window Whitney could see five of the seven basically independent modules that made up the Skyport and, just barely, the two port engines of the sixth. That would be all right; since only the center module's engines fired during this part of the flight, docking one module in from the end was essentially equivalent in noise and turbulence to docking in the end section. Docking one module from center, on the other hand, was rumored to be a loud and rather unnerving experience. It was a theory he wasn't anxious to test.

A flash of sunlight off to the left caught his eye—the second Houston shuttle, making its approach toward the second-to-last module at the other end. He watched with interest as the distant plane nosed toward its docking bay, watched it until the port-side engines of his own shuttle's target module blocked it from sight. The silvery trailing edge of the Skyport was very near now, and the slight vibration that had been building almost imperceptibly began to increase at a noticeable rate. Whitney was just trying to estimate the vibrational amplitude and to recall the docking bay's dimensional tolerances when a sound like a muffled bass drum came from the fuselage skin a meter in front of him and the vibration abruptly stopped. The docking collar, clamping solidly around them. With the noise of the Skyport's engines still filling the cabin, Whitney's straining ears had no chance

of picking up the nosewheel's descent into the docking bay; but he *did* distinctly hear the *thump* as the bay's forward clamp locked onto the nosewheel's tow bar. Only then, with the shuttle firmly and officially docked, did he realize he'd been holding his breath. He let it out with a wry smile, feeling more than ever like a kid on a ride Disney had never dreamed of.

Another soft thump and hiss signaled that the pressurized tunnel was in place. A cool breeze wafted through the shuttle as the outer door was opened—and suddenly Whitney and his seatmate were moving, their ski lift seats following the grooves in floor and ceiling as they were moved first into the aisle and then forward toward the exit. They turned left at the doorway, and Whitney caught just a glimpse of the shuttle's other seats in motion behind him. Then, with only the slightest jerk of not-quite-aligned grooves, they were out of the shuttle and into a flexible-walled corridor that looked for all the world like the inside of an accordion. The tunnel was short, leading to another airplane-type doorway. Straight ahead, stretching down a long corridor, Whitney could see a column of seats like his own, filled with passengers for the shuttle's trip back down to Houston. There didn't seem to be enough room beside the column for the emerging seats to pass by easily, but Whitney was given little time to wonder about it. Just beyond the doorway his seat took a ninety-degree turn to the right, and he found himself sidling alongside a wall toward what looked like a lounge. To his left he could see the rest of the shuttle's seats following like a disjointed snake. The airlines had balked at the ski lift system, he remembered, complaining that it was unnecessarily complicated and expensive. But the time the shuttle spent in the docking bay translated into fuel for its return flight, and the essence of *that* was money . . . and the ski lift system gave the shuttle a mere ten-minute turnaround.

It was indeed a sort of lounge the chairs were taking them into, a rectangular space done up with soft colors and a carpet designed to disguise the grooves in the floor. In the center was a large, four-sided computer display giving destinations and the corresponding modules in large letters. Whitney's seatmate retrieved her briefcase from under her chair and hopped off as the chair entered the room and began to sidle its way across the floor; glancing at the display, she strode out through one of the wide doorways in the far wall. Whitney obeyed the rules, himself, waiting until the seat had come to a complete stop before undoing his belt and standing up. He was in module six, the display informed him, and passengers for Los Angeles could sit anywhere in modules one, two, six, or seven. Since his boarding pass indicated he'd be disembarking from module six anyway, it made the most sense to just stay here, a decision most of the others also seemed to have reached. Picking up his carry-on, he joined the surge forward. A short corridor lined with lavatory doors lay ahead; passing through it, he entered—

Instant disorientation.

The room before him was *huge*, and was more a combination theater-cafe-lounge than an airplane cabin. Directly in front of him was a section containing

standard airline chairs, but arranged in patterns that varied from the traditional side-by-side to cozy circles around low tables. To either side were small cubicles partially isolated from the main floor by ceiling-length panels of translucent, gray-tinted plastic. Further on toward the front of the Skyport, partially separated from the lounge by more of the tinted plastic, was a section that was clearly a dining area, with tables of various sizes and shapes, about a third of them occupied despite the early hour. Beyond that, the last section seemed to be divided into three small movie/TV rooms.

It all seemed almost scandalously wasteful for a craft that, for all its size and majesty, still had to answer to the law of gravity; but even as Whitney walked in among the lounge chairs he realized the extravagance was largely illusory. Despite the varied seating, little floor space was actually wasted, and most of that would have been required for aisles, anyway. The smoked-plastic panels gave the illusion that the room was larger than it actually was, while at the same time added a sense of coziness to all the open space; and the careful use of color disguised the fact that the room's ceiling wasn't much higher than that of a normal jetliner.

For a few minutes Whitney wandered more or less aimlessly, absorbing the feel of the place. A rumble from his stomach reminded him that he'd had nothing yet that morning except coffee, though, and he cut short his exploration in favor of breakfast. Sitting down at one of the empty cafe tables, he scanned the menu card briefly and then pushed the call button in the table's center. Safety, he noted, had not been sacrificed to style; the table and chair were both fastened securely to the floor, and the metal buckle of a standard lap/shoulder belt poked diffidently at his ribs.

"Good morning, sir—may I help you?" a pleasant voice came from behind him. He turned as she came into view to his right: a short blonde, trim and athletic-looking in her flight attendant's uniform, pushing a steam cart before her. The cart surprised him a bit, but it was instantly obvious that true restaurant service for what could be as many as eight hundred passengers would be well-nigh impossible for the module's modest crew. Out of phase with the decor or not, precooked tray meals were the only way to serve such a crowd.

There were some illusions that even a Skyport couldn't handle.

"Yes. I'd like the eggs, sausage, and fruit meal—number two here," he told her, indicating it on the menu.

"Certainly." Opening a side door on her cart, she withdrew a steaming tray and placed it before him. The aroma rising with the steam made his stomach rumble again. "Coffee?" she added.

"Please. By the way, is there anything like a guided tour of the Skyport available? Upstairs, too, I mean?"

Her forehead wrinkled a bit as she picked up a mug and began to fill it. "The flight deck? I'm afraid not—FAA regulations forbid passengers up there."

"Oh. No exceptions, huh?"

"None that I know of." She set the mug down and placed a small cup of cream beside it. "Any special reason you'd like to go up there, or are you just curious?"

"Both, actually. I work for McDonnell Douglas, the company that built this plane. I've been doing computer simulations for them, and now they're transferring me to L.A. to do some stuff on their new navigational equipment. I thought that as long as they were flying me out on a Skyport anyway, it would give me a jump on my orientation if I could look around a bit."

The attendant looked duly impressed. "Sounds like interesting work—and about a million miles over my head. I can talk to the captain, see if we can break the rules for you, but I can't make any promises. Would you give me your name, please, and tell me where you'll be after breakfast?"

"Peter Whitney, and I'll probably be back in the lounge. And, look, don't go breaking any rules—this isn't important enough for anyone to get into trouble over."

She smiled. "Okay, but I'll see what I can do. Enjoy your meal, Mr. Whitney, and if you need anything else just use the caller." With another smile she turned her cart around and left.

Picking up his fork, Whitney cut off a bit of sausage and tasted it, and then sampled the eggs. Piping hot, all of it, but not too hot to eat—and it tasted as good as it smelled. Settling himself comfortably, he attacked his tray with vigor.

There was something magic about a Skyport flight deck.

Betsy Kyser had been flying on the giant planes for nearly eighteen months now—had been a wing captain, in charge of an entire hundred-meter-wide module, for four of them—and she still didn't understand exactly why this place always hit her so strongly. Perhaps it was the mixture of reality and fantasy; the view of blue sky through the tiny forward windows contrasting with the myriads of control lights and glowing computer readouts. Or perhaps it was the size of the flight deck itself, better than twice as large as that of a jumbo jet, that struck a chord within her, half awakening the dreams of huge spaceships she'd had as a child. Whatever the reason, she knew the feeling would wear off sooner or later . . . but until that happened, it was there for her to enjoy. Standing just inside the flight deck door, she drank her fill of the magic.

Slouched in the copilot's seat, Aaron Greenburg glanced back toward her, the gold wings on his royal-blue jumpsuit's shoulderboards winking at her with the motion. "Morning, Bets— thought I heard you come in," he greeted her.

"Morning, Aaron. Tom, Rick," she added as the pilot and flight engineer turned and nodded to her. "Any problems come up during the night?"

Tom Lewis, in the pilot's seat, raised his hands shoulder high in an expansive shrug. "What could go wrong?"

He had a point. Only the middle three wing sections ran their huge General Electric CF6-90C1 turbofan engines during normal flight, the outer two of those shutting down during the lower-speed shuttle pickups. Perched on the Skyport's starboard end, Wing Section Seven was essentially along for a free ride, with little to do but keep the passengers happy and make sure the fuel the shuttles brought up went down the internal pipeline to the sections that needed it. "You trying to tell me you

get *bored* up here?" she asked in mock astonishment. "*Here*, aboard the greatest flying machine ever built by mankind?"

Before Lewis could answer, a voice spoke up from the intercom. "Wassamatta, Seven; isn't our company good enough for you? What do you want—home movies and pretzels?"

"We could let them have some of the navigational work," a new voice suggested.

"*Great* idea. Seven, why don't you hop outside and take a sun-sight?"

"I've got a better idea, Five," Lewis said, turning back to the intercom grille. "Why don't we do a Chinese fire drill and send One, Two, and Three around to hook up on the other side of us and let *us* drive for a while."

"Sounds like fun," a voice Betsy recognized as One's night-shift pilot broke in. "It'd confuse the passengers all to hell, though. Do we tell them, or see if they figure it out by themselves?"

"Oh, we could switch back before we got to L.A.," Lewis told him.

"I've got an even better idea, Seven," the rumbling voice of Skyport Captain Carl Young said from Four. "Why don't you all cut the chitchat and get ready to receive the Dallas shuttle."

Lewis grinned. "Yes, sir. Chitchat out, sir."

Betsy stepped forward. "All the way out, as a matter of fact. You can go on back, Tom; I'll take over here."

"I've still got over a half hour left on my shift, you know," he reminded her.

"That's okay—the quality of intercom banter this morning indicates *everyone* on this bird is suffering gobs of boredom fatigue. Go on, get some coffee and relax. And maybe work on your one-liners."

Lewis gave her an injured look. "Well-l-l . . . okay. If you insist." Pulling off his half-headset and draping it across the wheel, he slid out of his chair and stepped back from the instrument panel. "All yours, Cap'n," he added. "Try not to hit anything; I'll be taking a nap."

"Right," she said dryly, slipping into his vacated seat. "Aaron, Rick—you two want to flip a coin or something to see who goes on break first?"

There was a short pause. Then Greenburg glanced back over his shoulder. "Why don't you go ahead," he said to Rick Henson. "I'd like to stay for a bit."

Henson nodded and got up from his flight engineer's board. "Okay. Be back soon." Together he and Lewis left the flight deck.

Betsy looked curiously at Greenburg. "Never known anyone before who didn't jump at a mid-shift coffee break with all four feet," she said.

"Oh, don't worry—I'll take mine, all right. I just wanted to give you a word of warning about the shuttle coming in. Eric Rayburn's flying her."

Betsy felt a knot form directly over her breakfast. "Oh, hell. I sure have a great sense of timing, don't I."

"I can call Tom back in if you'd like," Greenburg offered. "You're not technically on duty for another half-hour."

She was sorely tempted. By eight o'clock Skyport time—seven Dallas time—the shuttle would have come and gone and be back on the ground again,

and Eric Rayburn with it. She wouldn't have to talk to him, something she was pretty sure both of them would appreciate; and with her blood pressure and digestion intact she could go back to just flying her plane—

And to avoiding Eric.

"I can't avoid him forever, though, can I," she said, with a resigned sigh. "Thanks, but I'll stay here."

Greenburg's dark eyes probed her face. "If you're sure." He paused. "Shuttle's calling now," he informed her.

Nodding, she took the half-headset and put it on, guiding the single earphone to a comfortable spot in her left ear. Even before it was in place she heard Rayburn's clipped Boston accent. "—to Skyport Eleven-oh-three. Beginning approach; request docking instructions."

Betsy pursed her lips and turned on her mike. "Dallas shuttle, this is Skyport Eleven-oh-three. You're cleared for docking in Seven; repeat, Seven." Her eyes ran over the instrument readouts as she spoke. "Skyport speed holding steady at two-sixty knots; guidance system radar has a positive track on you."

"Is that you, Liz? Son of a gun; I had no *idea* I was going to have the honor of docking with *your* own Skyport. This is *indeed* a privilege."

Betsy had been fully prepared for heavy sarcasm, but she still found her hands forming into tight knots of frustration at his words. *Liz*—early in their relationship he'd learned how much she despised that nickname, and his continual use of it these days was a biting echo of the pain she'd felt at their breakup.

"Yes, this is Kyser," she acknowledged steadily. "Shuttle, you're coming in a bit fast. Do you want a relative-v confirmation check?"

"What for? I can fly my bird as well as you can fly yours, Liz."

"We're sure you can, Shuttle." Betsy's voice was still calm, but it was a losing battle and she knew it. "Dock whenever you're ready; we're here if you need any help." Without waiting for a response, she flipped off the mike and wrenched the half-headset off, cutting off anything else he might say.

For a moment she stared at the instruments without seeing any of them, slowly getting her temper back under control. Greenburg's quiet voice cut through the blackness. "You know, I'm always amazed—and a little bit jealous—whenever I come across someone with as much self-control as you've got."

She didn't look up at him, but could feel the internal tension ease a little. "Thanks. You're lying through your teeth, of course—I've never seen you even raise your voice at anyone—but thanks."

Her peripheral vision picked up his smile. "You give yourself too little credit, and me 'way too much. Inherent lack of temper isn't comparable with control of a violent one. *My* weaknesses are gin rummy and gin fizzes—usually together." He shook his head. "Eighteen months is a long time to carry a grudge."

"Yeah. I will never again let that old sexist cliché about a woman scorned go by unchallenged—some of you men are just as good at hell's fury as we are."

"If you'll pardon a personal question,

is all this nonsense *really* just because you were chosen for Skyport duty and he was left back in the shuttle corps? I'd heard that was all it was, but it seems such a silly thing to base a vendetta on."

She was able to manage a faint smile now. "That shows you don't know Eric very well. He's a very opinionated man, and once he gets hold of an idea he will *not* let it go. He is thoroughly convinced United put me on the Skyport because of my looks, because they thought it would be good publicity, because they needed a token female—*any* reason except that I might have more of the qualities they were looking for than he did."

"One of his opinions is that women are inferior pilots to men?" Greenburg hazarded.

"Or at least we're inferior pilots to *him*. My flying skills were perfectly acceptable to him until United made the cut. In fact, he used to brag a lot about me to his other friends."

Unknotting her fists, she stretched her arms and fingers. "The irony of it is that he'd be climbing the walls here his first week on duty. He's a good pilot, but he can't stand being under anyone's authority once he's left the cockpit. Even the low-level discipline we have to maintain here around the clock would be more than he'd be willing to put up with."

"Maverick types we don't need here," Greenburg agreed. "Well, try not to let him get to you. In just over ten minutes he'll be nothing more than a bad taste in your memory."

"Until the next time our paths cross," Betsy sighed. "It's so hard when I remember what good friends we once were." A number on one of the readouts caught her eye, and she leaned forward with a frown. "I still read him coming in a shade too fast. Aaron, give me a double-check—what's the computer showing on his relative-v?"

Greenburg turned to check. As he did so, Betsy felt the Skyport dip slightly, and her eyes automatically sought out the weather radar. Nothing in particular was visible; the bump must have been a bit of clear air turbulence. No problem; with a plane the size of Skyport normal turbulence was normally not even noticed by the passengers—

Without warning, her seat suddenly slammed up underneath her as the flight deck jerked violently. Simultaneously, there was a strangely indistinct sound of tortured metal . . . and, as if from a great distance, a scream of agony.

Betsy would remember the next few seconds as a period of frantic activity in which her mind, seemingly divorced from her body by shock, was less a participant than a silent observer. With a detached sort of numbness she watched her hands snatch up her half-headset —realizing only then that that was where the distant scream had come from—and jam it into place on her head. A dozen red lights were flashing on the instrument panel, and she watched herself join Greenburg in slapping at the proper controls and shutoffs, turning off shorting circuits and leaking hydraulics in the orderly fashion their training had long since drummed into them. And all the time she wondered what had gone wrong, and wondered what she was going to do. . . .

The slamming-open of the door behind her broke the spell, jolting her

mind back into phase with reality. "What the hell was *that?*" Henson called as he charged full-tilt through the doorway and dropped into his flight engineer's chair. Lewis was right behind him, skidding to a stop behind Greenburg.

"Shuttle crash," Betsy snapped. Emergency procedures finished, she now had her first chance to study the other telltales and try to figure out the exact situation. "Looks bad. The shuttle seems to have gone in crooked, angling upwards and starboard. Captain Rayburn, can you hear me? Captain Rayburn, report please."

For a moment she could hear nothing through her earphone but a faint, raspy breathing. "This is—this is Rayburn." The voice was stunned, weak, sounding nothing like the man Betsy had once known.

"Captain, what's the situation down there?" she asked through the sudden tightness in her throat. "Are you hurt?"

"I don't know." His voice was stronger now; he must have just been momentarily stunned. "My right wrist hurts some. John . . . oh, God! *John!*"

"Rayburn?" Betsy snapped.

"My copilot—John Meredith—the whole side of the cockpit's caved in on him. He's—oh, God—I think he's dead."

Betsy's left hand curled into a fist in front of her. "Rayburn, snap out of it! Turn on your intercom and find out if your passengers are all right. Then see if there's a doctor on board to see to Meredith. If he's alive every second could count. And use your oxygen mask—you've probably been holed and the bay's not pressurized."

Rayburn drew a long, shuddering breath, and when he spoke again he sounded almost normal. "Right. I'll let you know what I find."

A click signified the shuttle's intercom had been switched on. Listening to him with half an ear, Betsy pushed the mike away from her mouth and turned back to Greenburg. "Have you got a picture yet?" she asked.

The copilot was fiddling with the bay TV monitor controls. "Yeah, but the quality's pretty bad. He took out the starboard fisheye when he hit, and a lot of the overhead floods, too."

Betsy peered at the screen. "Port side looks okay. I wish we could see what he's done to his starboard nose. Top of the fuselage looks like it's taken some damage—up there, that shadow."

"Yeah. A little hard—"

"Betsy!" Henson broke in. "Take a look at the collar stress readouts. We've got big trouble."

She located the proper screen, scanned the numbers. There were six of them, one for each of the supports securing the docking collar to the edge of the bay. Four of the six indicated no stresses at all, while the other two were dangerously overloaded; and it took a half second for the significance of the zero readings to register. "Oh, great," she muttered, pulling the mike back to her lips. "Rayburn?"

"Passengers are okay except for some bruises and maybe sprains." Rayburn's voice was muffled, indicating he'd put his oxygen mask on. "We've got a doctor coming to look at John."

"Good. Now listen carefully. You're holding onto the Skyport by the skin of your teeth—four of the collar supports

have been snapped, and the drag on you is straining the last two. Start firing your engines at about—'' She paused, suddenly realizing she had no idea how much power he'd have to use to relieve the strain on the clamps. ''Just start your engines and run them up slowly. We'll tell you when you're at the right level.''

''Got you. Here goes.''

It took nearly a minute for the stresses to drop to what Betsy considered the maximum acceptable levels. ''All right, hold at that level until further notice,'' she told him. ''Is the doctor in the cockpit yet?''

''He's just coming in now.''

''When he's finished his examination give him a headset and let him talk to one of us here.''

''Yeah, okay.''

Pulling off her half-headset, Betsy draped it around her neck and looked over at Greenburg. ''Stay with him, will you? I need to talk to Carl.''

Greenburg nodded, and Betsy leaned over the intercom. ''Carl? This is Kyser on Seven.''

''We've been listening, Betsy,'' the Skyport captain's calm voice came immediately. ''What's the situation?''

''Bad. We've got a damaged—possibly wrecked—shuttle with a probably dead first officer aboard. A doctor's with him. Somehow the crash managed to tear out four of the docking collar supports, too, and if the other two go we'll lose her completely.''

''The emergency collar?''

''Hasn't engaged. I don't know why yet; the sensors in that area got jarred pretty badly and they aren't all working.''

''The front clamp didn't make it to the nosewheel, I take it?''

''No, sir.'' Betsy studied the TV screen. ''Looks like it's at least a meter short, maybe more.''

''Those clamp arms aren't supposed to run short, no matter where in the bay the shuttle winds up,'' someone spoke up from one of the other wing sections. ''Maybe it's just hung up on something, and in that case you should be able to connect it up manually from inside the bay.''

''There isn't supposed to be anything in there for the arm to hang up *on*,'' Greenburg muttered, half to himself.

Young heard him anyway. ''Unless the crash jarred something loose,'' he pointed out. ''Checking on that should be our first priority.''

''Excuse me, Carl, but it's not,'' Betsy said. ''Our first priority is to figure out whether something aboard Seven caused the crash.''

''A board of inquiry—''

''Will be too late. All our fuel comes up via these shuttles. If a flaw's developed in Seven's electronics or computer guidance programming we've got to find out what it is and make sure none of the other wing sections has it. Because if something *is* going bad, it has to be fixed before we can allow any more dockings. Otherwise we could wind up with *two* smashed shuttles.''

Behind her, she heard Lewis swear under his breath and head over toward the flight deck's seldom-used computer terminal. ''You're right,'' Young admitted. ''I hadn't thought that far. Can you run the check, or shall I send someone over to help?''

''Tom's starting on it now, but I'm

not sure what it'll prove. The computer's supposed to continually run its own checks and let us know if there's any problem. If there's a flaw the machine missed, a standard check isn't likely to find it, either."

"Then we'll go to the source. I'll put a call through to McDonnell Douglas and see if they can either run a deeper check by remote control or tell us how to do one."

Betsy glanced at her watch. Six-forty St. Louis time; two hours earlier in Los Angeles. They'd have to get the experts out of bed, a time-consuming process. She was just about to mention that fact when Paul Marinos, Six's captain, spoke up. "Wait a second. There's a guy aboard who works for McDonnell Douglas—Erin told me he'd asked her about a tour of the flight deck."

"Does he know anything about our electronics?" Young asked.

"I don't know, but she said he does *something* with computers for them."

Betsy turned around to look at Lewis, who shrugged and nodded assent. "Close enough," she told the Skyport captain. "Can you get him up here right away?"

"I'll go get him myself," Marinos volunteered. "I'll be there in a couple of minutes."

"All right. Let's get back to the shuttle itself, then," Young said. "Betsy, you said the collar supports were broken. Any idea how that happened?"

"I can only speculate that the collar had established a partial grip before the shuttle did its sideways veer into the bay wall."

"In that case, the crash may have left both the outer shuttle door and the exit tunnel intact. Any chance of getting the two connected and getting the passengers out of there?"

"I don't know." Betsy peered at the screen, made a slight adjustment in the contrast. "They're out of line, for sure. I don't know if the tunnel will stretch far enough to make up the difference."

"Even if it does, we'd need portable oxygen masks for all the passengers," Henson pointed out from behind her. "They have to be using the shuttle's air masks, and they can't travel with those."

"That's not going to be a problem," Young said. "I've already invoked emergency regulations; we're bringing her down to fifteen thousand feet."

"Well, there's nothing more I can tell from here." Betsy shook her head. "Someone's going to have to go down and take a look. Who aboard this bird knows the most about docking bay equipment?"

There was a pause. "I don't know whether I know the *most*," Greenburg spoke up diffidently at Betsy's right, "but I've seen the blueprints, and I worked summers as a mechanic's assistant for Boeing when I was in college."

"Anyone able to top that?" Young asked. "No? All right, Greenburg, get going."

Betsy put her half-headset back on as Greenburg removed his and stood up. "A set of the relevant blueprints would be helpful," he said, looking back at Lewis.

"I'm having the computer print them," the other told him. "If you want to go down and get the oxygen gear together, I'll come down and give you a hand."

Greenburg glanced questioningly at

Betsy. "Can you do without both of us that long?"

She hesitated, then nodded. "Sure. But make it a fast look-see. You're not going down there to do any major repair work."

"Right." Greenburg started for the door. "Meet you by the port-aft cargo access hatch, Tom."

Lewis waved an acknowledgment, his eyes on the computer screen, as Greenburg exited. Betsy turned back to face forward, and as she did so Rayburn's voice crackled in her ear. "Skyport, this is Rayburn. The doctor says John's alive!"

A small part of the tightness across Betsy's chest seemed to disappear. "Thank God! Is the doctor still there? I want to speak with him."

"Just a second." There was a moment of silence punctuated by assorted clicks, and then a new voice came tentatively on the line. "Hello? This is Dr. Emerson."

"Doctor, this is Wing Captain Elizabeth Kyser. What sort of shape is First Officer Meredith in?"

"Not a good one, I'm afraid," Emerson admitted. "He seems to have one or more cracked ribs and possibly a broken collarbone as well. The way the fuselage has bent inward and pinned him makes it hard to examine him. I could try pulling him out, but that might exacerbate any internal injuries, or even drive bits of glass into him from the broken windows. He's unconscious, but his vital signs are stable, at least for the moment. I'm afraid I can't tell you much more."

"Just knowing he's alive is good news enough," Betsy assured him. She thought for a moment. "What if we could cut the whole chair loose? Is there enough room behind him to move the chair back and get him out that way?"

"Uh . . . I think so, yes. But I don't know what we would do after that. I heard the flight attendant say the door was jammed."

Betsy frowned. Rayburn hadn't mentioned that to her. "We might be able to force it open anyway and get it connected to the rest of the Skyport. Are the rest of the passengers all right?"

"A few minor injuries, mostly bruises due to the safety belts. We've been very lucky."

So far. "Yeah. Thank you, Doctor. Please let us know immediately if there's any change."

"Got the prints, Betsy," Lewis called as she turned off the mike. "I'm heading down."

He was gone before she could do more than nod assent, leaving her and Henson alone. For some reason the empty seats bothered her, and she briefly considered calling in some of Seven's off-duty crewmen. But as long as they were stuck in this virtual holding pattern, extra help on the flight deck would be pretty superfluous. Turning back to the instrument panel, she felt a wave of frustration wash over her. So many unanswered questions, most of them crucial to the safety of one or more groups of people aboard the Skyport—and she was temporarily at a loss to handle any of them. For the moment there was nothing she could do but try and line up the problems in some sort of logical order: if A is true then B must be done, and D cannot precede either B or C. But it was like juggling or playing chess in

her head; there were just too many contingencies that had to be taken into account every step of the way.

Behind her the door opened, and she turned to see two men walk in. One she knew: Paul Marinos, captain of Wing Section Six. The other, a thirtyish young man in a three-piece suit, she'd never seen before. But she knew instantly who he was.

"Betsy," Marinos said, "this is Peter Whitney, of McDonnell Douglas."

Whitney had been daydreaming in his lounge chair, enjoying the unique Skyport atmosphere, when the violent bump jerked him back to full alertness. He shot a rapid glance around the room, half expecting to see the walls caving in around him. But everything looked normal. Up ahead, he could hear muttered curses from the dining room —prompted, no doubt, by spilled coffee and the like—while from the lounge itself came a heightened buzz of conversation. Whitney closed his ears to it all as best he could, straining instead to listen for some clue as to what had happened. An explosive misfire in one of the engines was his first gut-level guess; but the dull background rumble seemed unchanged. A hydraulic or fuel line that had broken with that much force might still be leaking audibly; again, he could hear nothing that sounded like that. Had there been that bogey of the '70s and early '80s, a mid-air collision? But even small planes these days were supposed to be equipped with the Bendix-Honeywell transponder system—and how could any pilot fail to see the Skyport in the first place?

The minutes dragged by, and conversational levels gradually returned to normal as the other passengers apparently decided that nothing serious had happened. Whitney suspected differently, and to him the loudspeaker's silence was increasingly ominous. Something serious *had* happened, and the captain was either afraid to tell the passengers what it was or the crew was just too damn busy fighting the problem to talk. Neither possibility was a pleasant one.

A flash of royal blue caught the corner of his eye, and he turned to see a chunky man in a Skyport-crew jumpsuit step from the dining area into the lounge. The flight attendant who'd served Whitney's breakfast was with him, and Whitney watched curiously as her gaze swept the room. It wasn't until she pointed in his direction and the two started toward him that it occurred to Whitney that they might be looking for *him*. Even then uncertainty kept him in his seat until there was no doubt as to their target, and he had barely enough time to stand up before they reached him.

"Mr. Whitney?" the jumpsuited man asked. His expression was worried, his tone was politeness laminated on urgency. The girl looked worried, too.

Whitney nodded, noticing for the first time the gold wings-in-a-circle pins on his chest and shoulderboards. A wing captain, not just a random crew member. Whitney's first hopeful thought, that this was somehow related to the tour he'd asked for, vanished like tax money in Washington.

"I'm Captain Paul Marinos," the other introduced himself. "We have a problem, Mr. Whitney, that we hope

you can help us with. Is it true that you work with computer systems for McDonnell Douglas?''

Whitney nodded, feeling strangely tongue-tied, but finally getting his brain into gear. They were almost certainly not interested in just general computer knowledge; his nodded affirmative needed a qualifier added to it. ''I know only a little about current Skyport programming, though,'' he told them. ''I mostly work with second-generation research.''

Marinos's expression didn't change, but his next words were almost a whisper. ''What we need is a malfunction check on our shuttle approach and guidance equipment. Can you do that?''

The pieces clicked almost audibly into place in Whitney's mind. It *had* been a crash, and one that all the Bendix-Honeywell collisionproofing in the world couldn't prevent. ''I don't know, but I can try. Where do I find a terminal?''

''On Seven,'' was the cryptic response. ''Come with me, please.''

Marinos led the way across the lounge and back into the dining room. A door in the right-hand wall brought them into one of the module's food preparation and storage areas. The blonde flight attendant left them at that point; moving forward through the galley, Marinos and Whitney arrived at an elevator. One deck up was a somewhat cramped hallway lined with doors—crew quarters, Whitney assumed. In the opposite direction a heavy, positive-sealing door stood across their path. Marinos unlocked it and swung it open; and to Whitney's mild surprise an identical door, hung the opposite way, faced them. The captain opened this one, too, and gestured Whitney through, sealing both doors again behind them. ''We're on Wing Section Seven now,'' he told Whitney, leading the way down a hall that mirror-imaged the one they'd just left. ''The wing captain here is Betsy Kyser. You'll be working with her and her crew.''

Beyond the hallway was a small lounge; passing through it, they entered what appeared to be a ready-room sort of place with a half-dozen jumpsuited men and women listening intently to an intercom speaker; and finally, they reached the flight deck.

''We appreciate your coming up here,'' Captain Kyser said as Marinos concluded the introductions. ''I hope you can help us.''

''So do I,'' Whitney said. ''Anything at all you can tell me about your malfunction? It might help my search.''

''All we know is that it's somewhere in the equipment or programming that guides shuttles into the docking bay.'' In a few terse sentences she told him what was known about the shuttle crash, including the craft's current orientation in the bay. ''My indicator said its approach velocity was too high, if that's significant,'' she concluded. ''But I don't know if that was just my indicator or if the whole system was confused.''

''The shuttle's radar is independent of your equipment, though, isn't it? Maybe the pilot can corroborate your readings.''

''Maybe—but if he'd seen anything wrong he'd almost certainly have yelled. But I'll ask him. First, though, I want to get you started. Paul, will you monitor the shuttle?''

Marinos, who had already quietly seated himself in the copilot's seat, nodded and put on a headset. Kyser removed her own and led Whitney to a console built snugly into the flight deck's left rear corner. Motioning him into the chair in front of it, she leaned over him and tapped at the keys. "Here's the sign-on . . . access code . . . and program file." A series of names and numbers appeared on the screen. "Any of those look familiar?"

"Quite a few, if the programming division's keeping its nomenclature consistent." Whitney scanned the list, experimentally keyed in a number.

"That's the standard equipment-check program," Kyser told him. "We've already run that one and come up dry."

"No errors? Then the problem probably isn't in the computer system."

She shook her head. " 'Probably' isn't good enough. Aren't there more complete test programs that can be run?"

"You're talking about the full-blown diagnostic monsters that ground maintenance uses." Whitney hesitated, trying to remember what little he knew about such programs. "It seems to me that the program should be stored somewhere in your system, probably on one of the duplicate-copy disks. The catch is that the thing takes up almost all of your accessible memory space, so anything that normally uses that space will have to be temporarily shut down while it's running."

Kyser looked over at the flight engineer. "Rick?"

"Jibes with what I've heard," he agreed. "Most of the programs that take a lot of space are connected with navigation, radar monitoring, and mechanical flight systems and cargo deck stuff. We're not using any of those at the moment, anyway, so that's no problem. I can also switch a lot of the passenger-deck functions from automatic to manual control." He craned his neck to look at Whitney, sitting directly behind him. "Will that free up enough memory?"

"I don't know—I don't know how much room it'll need. But there's another problem, Captain. Since it *is* such a big program, there'll almost undoubtedly be safeguards to keep someone from accidentally loading it and losing everything else in the memory."

"A password?"

"Of some kind." Whitney had been searching the program list and had already checked the descriptions of two or three of the entries. Another of them caught his eye and he keyed it in. "You may need to check with ground control to even find the name . . . hold it. Never mind, I've found it. DCHECK. Let's see. . . ." He advanced the description another page, skimmed it. "Here it is. We need something called the Sasquatch-3L package to load it."

"Will Dallas ground control have it?" Henson asked.

"I would think so—if not, they can probably get it by phone from one of the Skyport maintenance areas." Whitney hesitated. "But it's not clear whether or not that'll do you any good."

"Why not?"

"Well, remember that the whole reason you don't have the loading code in the first place is that they don't want you accidentally plugging in the program and wiping out something the autopilot's doing. So they may not legally

be able to release the code to a Skyport crew, especially one that's in flight."

"That's stupid!"

"That's bureaucratic thinking," Captain Kyser corrected—or agreed; Whitney couldn't figure out which. Leaning over Whitney's shoulder again, she spoke toward a small grille next to the display screen. "Carl? Did you get all that?"

"Yes," the intercom answered, "and I suspect Mr. Whitney's basically right. But there have to be emergency procedures for something like this—else why have the program stored aboard in the first place? It should simply be a matter of getting an adequately prominent official to give an okay. I'll get the tower on it right away."

"And hope your prominent official can move his tail this early in the morning," she muttered under her breath.

Whitney had been thinking along a separate track. "There's one other thing we can try," he said. "Can you patch me into the regular phone system from up here?"

"Trivially. Why?"

"I'd like to call my former supervisor back in Houston. He might be able to get the package, either from his own office or from someone in L.A."

"You just said it was illegal to release the code," Henson objected.

"To you, yes; but maybe not to me. I *work* for the company, after all."

Henson started to growl something vituperative, but Kyser cut him off. "We'll complain to the FAA later. For now, let's take whatever loopholes we can get our hands on. Put on that half-headset, Mr. Whitney, and I'll fix you up with Ma Bell."

The call, once the connection was finally made, was a remarkably short one. Dr. Mills, seldom at his best in the early morning, nevertheless came fully awake as Whitney gave him a thumbnail sketch of the crisis. He took down the names of both the diagnostic program and the loading code, extracted from Captain Kyser—via Whitney—the instructions for placing a return call to the Skyport, and promised to have the package for him in fifteen minutes.

"Well, that's it, I guess," Whitney remarked after signing off. "Nothing to do now but wait."

"Yeah. Damn."

Whitney looked up at her as she stared through the computer console, concentration drawing her eyebrows together. She had been something of a surprise to him, and he still found it hard to believe a Skyport wing captain could be so young. Marinos, he estimated, was in his early fifties, and Henson wasn't much younger. But if Betsy Kyser was anything past her early forties she was the best-preserved woman he'd ever seen. Which meant either United was hard up for Skyport personnel or Captain Kyser was one very fine pilot. He fixed the thought firmly in his mind; it was one of the few things about all this that was even remotely comforting.

"Uh . . . Captain?" he spoke up.

She focused on him, the frown lingering for a second before she seemed to notice it and eased it a bit. "Call me Betsy," she told him. "This isn't much of a place for formalities."

"I'm Peter, then. May I ask why you need to know about the electronics right *now?* I would think the shuttle's safety

would be the thing you need to concentrate on.''

''It is, but we can't do anything about that until we're sure more shuttles can dock safely.'' He must have looked blank, because the corner of her mouth twitched and she continued, ''Look. Whatever we wind up doing to the shuttle, odds are we don't already have the necessary equipment on board. That means—''

''That means you'll have to bring it up via shuttle,'' Whitney nodded, catching on at last. ''So you need to find the glitch in your docking program and make sure it hasn't also affected the other modules' equipment.''

''Right. After that the next job'll be to either get the passengers out or secure the shuttle into the bay, whichever is faster and safer.''

Whitney nodded again. In his mind's eye he could see the damaged shuttle hanging precariously out the back of the Skyport, holding on by the barest of threads. The picture reawakened the half-forgotten vertigo of his first—and last—rollercoaster ride twenty years ago, and he discovered he was gripping the arms of his chair a shade more tightly than necessary. Firmly he forced his emotions down out of the way. ''There's going to be a fair amount of drag on the shuttle from the Skyport's slipstream,'' he commented, thinking aloud as a further distraction from discomfiting images. ''That means a lot of stress on the docking collar. Would it help any if the shuttle dumped its fuel, to make itself lighter?''

''Just the opposite; the eng—'' She paused, a strange look flickering across her face. Behind her, Whitney saw peripherally, Marinos had swiveled around, his attention presumably attracted by Betsy's abrupt silence. ''Paul,'' she said without turning, ''run a calculation for me. At its present rate of burn, how much fuel has the shuttle got left?''

''What diff—?'' Marinos stopped, too, the same look settling onto his own features. Turning back, he began punching calculator buttons.

''Right,'' Betsy muttered tartly. ''We've gotten too used to the easy transfer of fuel between shuttle and Skyport . . . or I have, anyway.'' Whitney had figured out what was going on, but Betsy spelled it out for him anyway. ''You see, Peter, the shuttle's currently firing its engines, at about medium power, to counteract the drag you mentioned. I guess I was subconsciously assuming we could feed it all the fuel it needed from the Skyport's reserves.''

''But the connections are out of line?''

''Almost certainly. The fuel line's on the starboard side, too, which means there's not likely to be enough room to even get in and connect them manually. Probably no access panels close enough, either, but I guess we'll have to check on that.'' She grimaced. ''Something else to do. I hope someone's keeping a list.''

''Got it, Betsy,'' Marinos said, looking up once more. ''At current usage, he'll run dry in a little over seven hours.''

''Seven hours.'' She pursed her lips. ''And that assumes neither of his main pumps was rattled loose by the impact. Carl?''

''I heard, Betsy,'' the intercom grille said. ''That's not a lot of time.''

"No kidding. How much fuel has the whole Skyport got; for our own flying, I mean?"

"At our current speed, a good ten hours. All the tanks were pretty full."

"Okay. Thanks."

"Still no word from ground control on your program," he added. "They're trying to look up the regs and track down the guy who's got the actual package, and doing both of them badly."

"Betsy?" Marinos again. "Sorry to interrupt, but it's Eric Rayburn on the shuttle. He wants to talk to you."

Whitney started to reach for the earphone he was wearing, but Betsy shook her head, stepping back to her chair and picking up her own set. "This is Kyser," she said into the slender mike.

"Liz, what the hell's going on up there?" a harsh voice said into Whitney's left ear.

With the kind of crisis they were all facing up here, Whitney wouldn't have believed the tension on the flight deck could possibly increase. But it did. He could feel it in the uncomfortable shifting of Henson in his chair, and in Marinos's furtive glance sideways, and in Betsy's tightly controlled response. "We're trying to figure out how to get you and your passengers out of there alive," she said.

"Well, it's taking a damn sight too long. Or have you forgotten that John's in bad shape?"

"No, we haven't forgotten. If you've got any suggestions let's hear them."

"Sure. Just open this damn collar and let me fly my plane back to Dallas."

Betsy and Marinos exchanged glances; Whitney couldn't see Betsy's face, but Marinos's looked flabbergasted. "That's out of the question. You don't even know if the shuttle will fly any more."

"Sure it will! I've still got control of the engines and control surfaces. What else do I need?"

"How about electronics, for starters? You apparently don't even have enough nav equipment left to know where you are. For your information, you wouldn't be flying 'back' to Dallas, because we haven't left—we're circling the area at fifteen thousand feet and about two-seventy knots."

"All the better. I won't need any directional gear to find the airport."

Betsy's snort was a brief snake's hiss in Whitney's ear. "Eric, did you turn your oxygen off or something? Neither you nor the shuttle is in any shape to fly. Period." Rayburn started to object, but she raised her voice and cut him off. "We know you're worried about your first officer, but once we make sure it's safe to dock again we can have doctors and emergency medical equipment brought aboard to take care of him."

"And then what? Try to land with me still hanging out your rear? Don't be absurd. Like it or not, you're eventually going to have to let me go. Let's do it now and get it over with."

"No," Betsy said, and Whitney could hear a tightness in her voice. "There are a minimum number of tests we'll have to run before we can even consider the idea. You can help by starting a standard pre-flight check on your instruments and systems and figuring out what's still working. Other than that, you'll just have to sit back and wait like the rest of us."

"Wait!" He made the word an obscenity.

"Skyport out." Betsy reached over and flipped a switch, then pushed her mike off to one side. Whitney couldn't see much more than the back of her head, but it was very obvious that she was angry. He shifted uncomfortably in his chair, wishing he were somewhere else. There'd been elements about the whole exchange that had felt like a private feud, and he felt obscurely embarrassed that he'd been listening in.

"Don't let him get to you, Betsy," Henson advised quietly. "He's not worth getting upset about."

"Thanks." Already she seemed to be getting her composure back. "Unfortunately, he *did* hit one problem very squarely on the head."

"The landing problem?" Marinos asked.

Betsy nodded. "I don't know how we're going to handle that one."

"I don't understand," Whitney spoke up hesitantly. "You would just be separating off this module and landing it with the shuttle, wouldn't you?" A horrible thought struck him. "I mean you *aren't* thinking about landing the whole Skyport . . . are you?"

Betsy did something to her chair and swiveled halfway around to look at him. "No, of course not. There isn't a runway in the world that could take an entire Skyport, although the space shuttle landing area at Rogers Dry Lake might be possible in a real emergency."

"Then what's the problem? The modules are supposed to be able to land on an eighteen-thousand-foot runway, and Dallas has to have at least one that's that long."

"The eighteen thousand is for a wing section by itself, Peter," Marinos said patiently. He held up a hand and began ticking off fingers. "First: with the extra weight and—more importantly—the extra drag, we'd have to put down at something above our listed one-sixty-five-knot landing speed. That'll add runway distance right off the bat. Second: one of the weight savings on the wing sections is not having thrust reversers on our engines to help us slow down. We rely on landing wheel brakes and drogue chutes that pop out the back. With the shuttle adding weight out the back—and its gear will be at least a couple of feet off the ground when ours touches down, so there'll be a *lot* of weight—our balance will change. That means a little less weight on the front landing gear, which means a little less braking ability for those six sets of wheels. Maybe significantly less, maybe not; I don't know. And third, and probably most important: the drogue chutes come out the center and ends of our trailing edge—and we won't be able to use any of the center ones while the shuttle's in the way." He shook his head. "I wouldn't even attempt to land on anything shorter than twenty-five thousand under conditions like this."

"I'd hold out for thirty, myself," Betsy agreed grimly. "We just don't *know* how much extra room we'd need. And don't bother suggesting we put down on a cotton field or straddling both lanes of Interstate 20. One of the other ways you save weight on a Skyport is in the landing gear, and landing on something too soft would tear it to shreds."

An idea was taking shape in the back of Whitney's mind . . . but he wanted to think about it before saying anything

to the others. "So that leaves, what, the Skyport maintenance facility outside L.A.?" he asked instead.

"Or the one in New Jersey," Betsy said. "L.A.'s closer." She looked at her watch—the fourth time, by Whitney's count, that she had done so in the last ten minutes. "Damn it all, what's holding up ground control?"

As if in answer, the intercom suddenly crackled. "Bets, this is Aaron," a voice said. "We're ready here to start on down."

"Roger, Aaron; keep your line open," Betsy's voice said, too loudly, in Greenburg's ear. He resisted the impulse to turn down the volume on his portable half-headset; in a moment there would be another aluminum-alloy deck between them that should take care of the problem.

"Right. We're opening the access hatch now." As Lewis looked on, Greenburg undid the three clasps securing the surprisingly light disk and levered it up, making sure it locked solidly into its wall latch. Feeling around the underside of the hatch rim, he located the light switch and turned it on. The blackness below blazed with light, and with a quick glance to make sure he wouldn't be landing on unstable footing he grasped the rungs welded to the hatch and started down the narrow metal ladder, tool belt banging against his thigh.

The lowest of the Skyport's three decks was devoted to passenger luggage and general cargo and to the equipment necessary to move it from shuttle to Skyport, between wing sections where necessary, and back to shuttle again. The hatch the two men had chosen led to one edge of the cargo area, and most of the equipment in Greenburg's immediate area seemed to be motors and electronic overseers for the intricate network of conveyor belts and electric trams that sorted incoming luggage by destination and carted it to the proper storage area. All without human supervision, of course—and, despite that, it generally worked pretty well.

"The bay is straight back that way." Lewis had appeared beside him, clutching a sheaf of computer paper. "I think around that pillar thing would be the best approach."

They set off. Greenburg had been on a Skyport cargo deck only once, back in his training days, and was vaguely surprised at the amount of dirt and grease around the machinery they passed. Within a dozen steps his blue jumpsuit had collected a number of greasy smears and he found himself wishing he'd had the extra minute it would have taken to change into something more appropriate for this job. But even a minute could make a lot of difference . . . and Bets was counting on them.

They reached the curved wall that was the lower half of the docking bay within a few minutes, arriving just forward of a wide ring bristling with hydraulic struts that Greenburg knew marked the position of the emergency docking collar. He glanced back at it as they headed forward under the wall's curve, wondering why the backup system hadn't worked. It should have kicked in as soon as the main collar's supports gave way.

"Watch your step," Lewis said sharply, and Greenburg paused in midstep, focusing for the first time on the

dark-red puddle edging onto the path in front of him. Peering along the base of the wall, he could see more of the liquid, more or less collected in a narrow trough there. He squatted, touched it tentatively with a fingertip. It felt thick and oily. "Hydraulic fluid?" Lewis asked.

"Yeah. From the emergency collar, probably." Greenburg straightened and, with only a slight hesitation, rubbed the fluid off on his jumpsuit. Stepping carefully around the puddle in his path, he continued on.

The panel they'd decided on was precisely where the blueprints had said it would be: some two meters around the port wall from the heavy forward clamp machinery at the docking bay's forward tip. About forty centimeters by seventy, the panel sat chest-high in the wall and was, for a wonder, not even partially blocked by any of the conveyor equipment. Selecting a wrench from his belt, Greenburg began loosening the nuts.

"I hope there's nothing in here that can't take low air pressure," Lewis remarked as he untangled the two oxygen sets he was carrying and clipped one of the tanks onto the back of Greenburg's belt. "You want me to put the mask on you?"

"I'll put it on when I get this open," Greenburg grunted as he strained against a particularly well tightened nut. "I don't like stuff hanging from my face while I'm working. Distracts me."

"Put it on before you lose pressure in there, Aaron," Betsy's voice came in his ear.

"Aw, come on—Bets," he said, the last word a burst of air as the nut finally yielded. "We're only a thousand feet or so higher than Pikes Peak, and I've been climbing around up there since I was ten. I'm not going to black out up here for lack of air."

"Well . . . all right. But I want it on you as soon as you've finished with the panel."

"Sure."

It took only a couple of minutes to loosen all the nuts and, with Lewis's help, remove them and force the panel out of its rubber seating. For a minute there was a minor gale at their backs as the pressure inside the cargo deck equalized with that in the bay, and Greenburg realized belatedly he'd forgotten to check whether or not Lewis had remembered to close the hatch behind him. If he hadn't, this windstorm was going to keep going for quite a while . . . but even as he finished adjusting his oxygen mask over his nose and mouth the rush of air began to subside and finally stilled completely. "Here goes," Greenburg muttered as, stooping slightly, he eased his head through the opening, blinking as a cold breeze swept his face.

It was an impressive sight. Even twisted too far toward the bay's starboard wall, the shuttle's nose still seemed almost close enough for him to touch as it loomed over him, vibrating noticeably in the incomplete grip the broken collar provided. To his left and only slightly below him, he could see that the shuttle's front landing gear had descended just as it was supposed to, and was hanging tantalizingly close to the extended forward clamp. Moving his mike right up against his oxygen mask—it was noisier in the bay than he'd expected—he said, "Okay. First of all, I can't see anything that could be interfering with the clamp or arm. Rick, do

the telltales read the arm as fully extended?''

A short pause, then Henson's voice. ''Sure do. It's still got lateral and vertical play, though. Want me to swing it around any?''

''Waste of time, as long as it's too short. Someone's going to have to go down there and take a look at it, I guess.''

''That's not your job, though,'' Betsy spoke up. ''Carl's lining up a mechanical crew to come up from the airport as soon as it's safe. They can do all the work that's needed in the bay.''

''I'm sure they'll be thrilled at the prospect—and don't worry, I wasn't volunteering.'' Greenburg twisted his head around the other direction. ''Now, as to the shuttle door . . . hell. I can't be certain, but it looks like the edge of the collar is overlapping it—the shuttle must have slid back and then shot forward and starboard as the collar was engaging. What the hell kind of guidance system error could have caused *that?*''

''We should know in ten or fifteen minutes,'' an unfamiliar voice put in.

''Who's that?'' Greenburg asked.

''Sorry—maybe I shouldn't have butted in. I'm Peter Whitney; I'm helping to run the diagnostic program that will hopefully locate the problem.''

Peter Whitney?—ah, the McDonnell Douglas computer expert Paul Marinos had said he was bringing in. ''Have you got the program running yet?''

''Yes; a friend just radioed us the loading code.''

''Well ahead of ground control's efforts, I might add,'' Betsy said. ''We'll let you know when we identify the glitch. For now, let's get back to the shuttle door, okay? We think the sensors indicate hydraulic pressure problems in the emergency collar. Is there any chance we could fix that and get it to lock onto the shuttle? Then we could release the main collar and get the shuttle door open.''

Greenburg shifted position again and peered at the top of the shuttle, wishing all the floodlights hadn't gone when the craft hit. ''I don't think there's any chance at all,'' he said slowly. ''As a matter of fact, it looks very much like the emergency collar's responsible for most of the cockpit damage. It seems to have come out of the wall just in time for the shuttle to ram into it. If that kind of impact didn't do anything more than rupture a hydraulic line or two, I'll be very much surprised.''

Betsy said something under her breath that Greenburg didn't catch. ''You sure about that?'' she asked. ''I can't see any of that on the monitor.''

''As sure as I can be on this side of the bay. I can go to the starboard side if you'd like and check through the panel there. Probably have to go over there to find out exactly where this fluid came from, anyway.''

''Maybe later. Any other good news for us from there, first?''

''Actually, this *is* good news. Somehow, while the shuttle was rattling around the bay, it completely missed the Skyport passenger and cargo tunnels. If we can get everybody *out* of the shuttle, we can get them *into* the Skyport.''

''Well, that's something. Any suggestions on how we go about carrying out that first step?''

Greenburg frowned. Something about

the shuttle was stroking the warning bells in his brain . . . but he couldn't seem to put his finger on the problem.

"Aaron?"

"Uh . . . yes." His eyes still probing the vibrating fuselage, Greenburg replayed his mental tape of Betsy's last question. "The, uh, side window of the cockpit seems undamaged. It should be big enough for most of the passengers to squeeze through. Of course, it's a four-meter drop or thereabouts, so we'd need to rig up some way to either get them down and then back up to the tunnel door or else to get them across to it directly. Maybe rig something up to the ski lift mechanism in the tunnel . . ."

His voice trailed off as the warning bells abruptly went off full force. *The nosewheel was slightly closer to him!*

"Bets, the shuttle's sliding backwards!" he shouted into the mike. "The collar must be slipping!"

For a few seconds all he could hear was the muffled, indistinct sound of frantic conversation. Eyes still glued to the slowly moving nosewheel, he jammed his earphone tighter against his ear. "Bets, did you copy? I said—"

"We copied," Paul Marinos's voice told him. "Betsy's getting the shuttle to boost its thrust. Stand by, okay?"

Pursing his lips tightly under his oxygen mask, Greenburg shifted his gaze back along the shuttle to its main passenger door. If the collar was slipping he should be able to see the door slowly sliding further and further beneath the huge ring. . . . He still hadn't decided if it was moving when Betsy's voice made him start.

"Aaron? Is the shuttle still moving?"

"Uh . . . I'm not sure. I don't think so, but all the vibration makes it hard to tell."

"Yeah." A short pause. "Aaron, Tom, you've both done some shuttle flying, haven't you? What are the chances Rayburn could bring this one down safely, damaged as it is?"

Something very cold slid down the center of Greenburg's back. Betsy knew the answer to that one already—they all did. The fact that she was asking at all implied things he wasn't sure he liked. Surely things weren't desperate enough yet to be grasping at *that* kind of straw . . . were they?

Lewis, after a short pause, gave the only answer there was. "Chances are poor to nonexistent—you know that, Betsy. He'd have to leave here at a speed of at least a hundred sixty-five knots, and with one or more windows gone in the cockpit he'd have an instant hurricane in there. He sure as hell won't be able to fly in that, and I personally wouldn't trust any autopilot that's gone through what his has."

"You can't slow down past a hundred sixty-five knots?" Whitney, the computer man, asked.

"That's our minimum flight speed," Lewis told him shortly.

"I know that. What I meant was whether you could try something like a stall or some other fancy maneuver that would pull your speed temporarily lower."

"Wouldn't gain us enough, I'm afraid," Betsy said, sounding thoughtful. "Besides which, wing sections aren't designed for fancy maneuvers." She seemed to sigh. "We've got a new problem, folks. The shuttle's backwards drift, Aaron, was *not* the collar slipping.

It was the last two supports *bending*, apparently under slightly unequal thrusts from the shuttle's engines."

Lewis growled an obscenity Greenburg had never heard him use. "What happens if they break? Does the collar fall off the shuttle?"

"The book says yes—but exactly *when* it goes depends on how fast the hydraulic fluid drains out. My guess is it would hold on long enough to turn the shuttle nose down before dropping off and crashing somewhere in the greater Fort Worth area."

"Followed immediately by the shuttle," Greenburg growled. His next task was clear—too clear. "All right, say no more. Tom, there should be a supply locker just forward of here. See if there's any rope or cable in it, would you?"

"What do you want that for?" Betsy asked, her tone edging toward suspicious.

"A safety harness. I'm going to go inside the bay and see if there's any way to get that forward clamp connected. Tom?"

"Yeah, there's some rope here. Just a second—I have to untangle it."

"Hold it, Tom," Betsy said. "Aaron, you're not going in there. You're a pilot, not a mechanic, remember? We'll wait for some professionals from the ground to handle this."

"Wait how long?" he shot back, apprehension putting snap into his tone. "Rayburn can't keep firing his engines all day; and even if he could you have no guarantee the thrusts from all three turbofans would stay properly balanced. Do you?"

There was a short silence, during which Greenburg was startled by something snaking abruptly across his chest. It was Lewis, perhaps sensing the outcome of the argument, starting to tie Greenburg's safety line around him. "No," Betsy finally answered his question. "Rayburn's on-board can't give us those numbers any more, and the support stress indicators aren't really sensitive enough."

"Which means chances are good the shuttle's going to continue putting stresses on the clamps—variable stresses, yet. They're bound to fatigue eventually under that kind of treatment."

"Mr. Greenburg—Aaron—look, the program's almost finished running." Whitney, putting in his two cents again. "Once it's done we can have people up here in fifteen minutes—"

"No; only once we've found the problem *and made sure the other wing sections don't have it.* Who knows how long *that'll* take?" A tug on the rope coming off the chest of the makeshift harness Lewis had tied around him and a slap on the back told him it was time. Gripping the edges of the opening, he raised a foot, seeking purchase on the curved wall. Lewis's cupped hands caught the foot, steadied it. Greenburg started to shift his weight . . . and paused. He was still, after all, under Betsy's authority. "Bets? Do I have permission to go?"

"All right. But listen: you've got *one* shot at the clamp, and whether it reaches or not you're coming straight out afterward. Understand? No one's ever been in a docking bay during flight before, and you're not equipped for unexpected problems."

"Gotcha. Here goes."

Greenburg had spent the past couple of minutes studying the curving bay wall, planning just how he was going to do this maneuver. Now, as he shifted his weight and pushed off of Lewis's hands, he discovered he hadn't planned things quite well enough. Pushing himself more or less vertically through the narrow opening, he twisted his body around as his torso cleared, coming down in a sitting position with his back to the shuttle. But he'd forgotten about the oxygen tank on the back of his belt, and the extra weight was enough to ruin his precarious balance and to send him sliding gracelessly down the curving metal on his butt.

He didn't slide far; Lewis, belaying the line, made sure of that. Getting his legs back around underneath him, Greenburg checked his footing and nodded back toward the opening. "Okay, I'm essentially down. Let me have some slack." Moving carefully, he stepped down into the teardrop-shaped well under the shuttle and walked to the nosewheel.

The forward clamp was designed to slide out of the wall as the landing gear was lowered, locating the tow bar by means of two short-range transponders installed in the gear. Earlier, up on the flight deck, Greenburg had confirmed the clamp operation had been begun but not completed; now, on closer study, the problem looked like it might be obvious.

"The shuttle's not only angled into the bay wrong, but it's also rotated a few degrees on its axis," he reported to the others. "I think maybe that the clamp's wrist rotated as far as it could to try and match, and when it couldn't get lined up apparently decided to quit and wait for instructions."

"The telltales say it *is* fully extended, though," Henson insisted.

"Well . . . maybe it's the sensors that got scrambled."

"Assume you're right," Betsy said. "Any way to fix it?"

"I don't know." Greenburg studied the clamp and landing gear, acutely aware of the vibrating shuttle above him—and of the vast distances beyond it. *But even if the shuttle fell out and my rope broke I'd be all right*, he told himself firmly. Standing in the cutout well that gave the shuttle's nosewheel room to descend, he was a good two meters below the rim of the bay's outer opening. There was a fair amount of eddy-generated wind turbulence plucking at his jumpsuit and adding a wind-chill to the frigid air—but it would take a *lot* of turbulence to force him up that slope and out. At least, he thought so. . . . "Why don't you try backing the clamp arm up and letting it take another run at the tow bar?"

"We'll have to wait for Peter's program to finish," Henson said. "The computer handles that."

"Oh . . . right." Greenburg hadn't thought of that. "How much longer?"

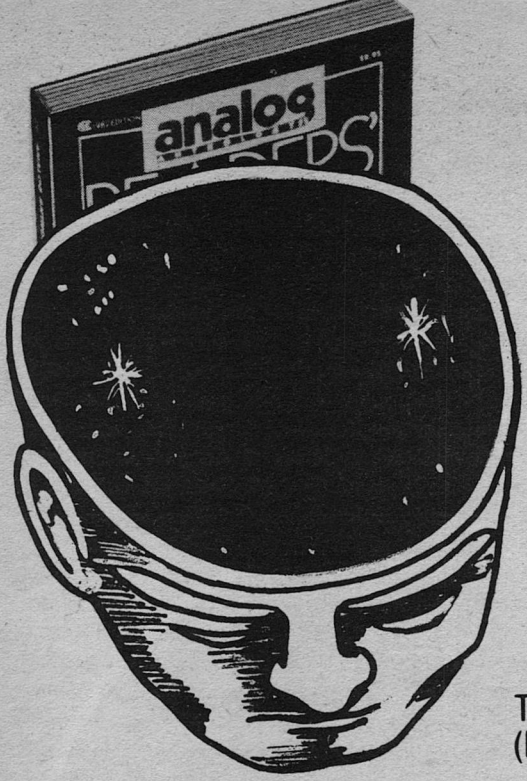
"It's almost—it's done," Whitney said.

"Where's the problem?" Betsy asked. Even with the turbofan engines droning in his ears Greenburg could hear the twin emotions of anticipation and dread in her voice.

"There doesn't seem to be one."

"That's ridiculous," Greenburg said. "*Something* made the shuttle crash."

"Well, the program can't find it.



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Look, it seems to me I felt the Skyport bounce a little just before the crash—''

''Clear air turbulence,'' Betsy said. ''That shouldn't have been a problem; the guidance program is supposed to be able to handle small perturbations like that.''

''Let's forget about the 'how' of it for now,'' a new voice broke in—Carl Young's, Greenburg tentatively identified it through the noise. ''The point is that we can start bringing shuttles back up again. Greenburg, is there anything you can suggest we bring up from the ground to secure the shuttle with?''

''Uh . . . hell, I don't know. Something to use to get the passengers off would certainly be handy. And if this clamp arm won't rotate any further we might need an interfacing of some kind—maybe an extra clamp-and-wrist piece to extend our clamp's rotational range.''

''I've already ordered some spare ski lift track from the ground—it should be coming up aboard the first shuttle, along with men to handle it. The clamp-and-wrist section we may be able to remove from one of the other bays; other people will be coming up to try that. What I meant was, can you see anything from there that we didn't already know about?''

''Not really.'' Greenburg was starting to feel a little foolish as his brave descent into the bay began to look more and more unnecessary. With the guidance system coming up clean, shuttleloads of experts would be here in minutes. *So much for the value of impulsive heroics*, he thought acridly; but at least it hadn't wasted too much time. He'd always been much better as a team player, anyway. ''Hold on tight, Tom; I'm coming up,'' he called, getting a grip on his safety line.

''Just a second, Aaron,'' Henson said. ''I've got the computer back now. Why don't you stay put while I try the clamp again like you suggested.''

''All right. But make it snappy—it's freezing in here.''

There was a heavy click, and the clamp arm telescoped smoothly back into itself, rotating to the horizontal as it did so. It paused for a second when fully retracted and then reversed direction, angling toward the landing gear like some rigid metallic snake attacking its prey in slow motion. It stopped, again a meter short, and with a sinking feeling Greenburg saw his mistake. ''It's not just the angle the nosewheel's at,'' he informed the others. ''The clamp rotates a little as each segment telescopes out, not all at once at the end of the extension. It's not quitting because it doesn't know how to proceed—it's quitting because it's run out of length.''

''That's impossible,'' Betsy retorted. ''I've checked the stats—the arm's *got* to be long enough to reach.''

''Then it's been damaged somehow,'' Greenburg said irritably. If they had to replace the whole arm, and not just the clamp . . . He shivered as a newly sharpened sense of the shuttle's vulnerability hit him like a wet rag.

For a moment the drone of the turbofans was all he could hear. Then Carl Young said, ''We'll have the ground people check it out when they get here. Greenburg, you might as well come out of there. You'll need to put the access

panel back in place temporarily so we can repressurize the deck."

"Understood." Turning back to the curving wall, his hands numb with cold, Greenburg began to climb.

"The shuttle will dock in Six in about four minutes," the Skyport captain's voice came over the intercom.

"Okay, Carl," Betsy said. "Six, do you have someone at the bay to meet it?"

"Not yet," was the response. "We wanted to have all the stations up here manned during docking, to watch for any trouble. We could call in somebody off-duty, if you want."

"Don't bother," Paul Marinos said, unbuckling his seat belt and getting to his feet. "I'll go down and meet the shuttle. You won't need me before Tom gets back, will you?" he added looking at Betsy.

She shook her head. "Go ahead. As a matter of fact, you can probably escort Mr. Whitney back down on your way. Mr. Whitney, we very much appreciate your help here this morning."

"Uh, yeah. You're welcome."

Unlocking her chair, Betsy swiveled around. Whitney was hunched forward in his own seat, frowning intently at the computer display screen. "Anything wrong?" she asked, her mouth beginning to feel dry again. That shuttle would be trying to dock in a half-handful of minutes. . . .

Whitney shook his head slowly, his eyes never leaving the screen. "I'm just rechecking the readout, trying to see if there's anything that looks funny but somehow didn't register as a problem." He keyed for the next page; only then did he look up. "If it's not too much trouble, though, I'd really like to stay up here for a while. I can be an extra hand with the computer, and there's another project I want to discuss with you."

"Passengers usually aren't permitted up here at all," Marinos said with a frown.

Whitney shrugged. "On the other hand, I *am* already here."

"All right," Betsy said, making a quick decision. Even if Whitney's primary motivation was nothing more than simple curiosity, he'd already been a big help to them. It was an inexpensive way to pay back the favor. "But you'll have to stay out from underfoot. For starters—" she pointed at the display —"you'll need to finish that up quickly, because Tom Lewis's on his way up to make some more blueprints."

"Yes, I know. I'll be finished." He turned back to the console. Nodding to her, Marinos left the flight deck.

Swiveling back forward, Betsy squeezed her eyes shut briefly and took a long, deep breath. The tension was beginning to get to her. She could feel her strength of will slowly leaking away; could feel her decision-making center seizing up—and this only some eighty minutes into the crisis.

The strength of her reaction was more than a little disturbing. True, the lives of a hundred-sixty people were hanging precariously in the balance back there . . . but she'd been holding people's lives in her hands since her first flight for the Navy back in 1980. She'd had her share of crises, too, probably the worst of them being the 747 that had lost power in all four engines halfway

from Seattle to Honolulu. She'd had to put the monster into a five-thousand-foot dive to get the balky turbofans restarted—and she hadn't felt anything like the nervousness she was feeling now. Was it just the *length* of this crisis that was getting to her, the pumping of adrenaline for more than five minutes at a time? If so, she was going to be a wreck by the time this whole thing was resolved. Or—

Or was it the people—*be honest, Betsy; the* person—involved? Could being forced to deal with Eric Rayburn again really hit her this hard?

"Excuse me, Captain; is it all right if I sit here?"

She opened her eyes to see Whitney standing beside her, indicating the co-pilot's seat. Craning her neck, she saw that Lewis had returned and had taken over the computer terminal again. "Yeah, sure," she told Whitney, thankful for the interruption. "Just don't touch anything. Tom, you need any help?"

"No, thanks; just getting the schematics for the clamp arm mechanism, the emergency collar, and whatever I can find on the Skyport door and tunnel." Paper was beginning to come from the printer slot; Lewis glanced at it and then looked at Betsy. "Anything new from the shuttle?"

"Rayburn's still checking out his instruments. So far the altimeter, Collins nav system, and at least one of the vertical gyros seem to be out; the compass and collisionproofing are intact; the autopilot is a big question mark."

"I met Paul Marinos on the way up here. He said it was Rayburn who came up with that half-assed idea of letting the shuttle fly home alone."

"That's right," Betsy confirmed. "He's still making noises in that direction, too."

"Good. Aaron and I thought *you'd* thought it up, and we were getting a little worried."

She snorted. "Thanks for your confidence. You staying with Aaron after you deliver the schematics?"

"Depends on whether they need me or not," he said, pulling the last sheet from the printer slot and flipping the "off" switch. "Talk to you later."

He got up and left, and as he did so the intercom crackled. "This is Marinos. The shuttle has docked. Textbook smooth, I might add."

Betsy turned to the intercom grille, feeling a minor bit of the weight lift from her shoulders. "Aaron, you copy that? Prepare for company down there."

"Got it. Paul, let me know when you're all down, so I can start taking this panel off again."

"Will do."

The intercom fell silent, and Betsy leaned back in her seat again. Staring out the window at the blue sky, she tried to organize her thoughts.

"Captain? Are you all right?"

She glanced at Whitney, favoring him with a half smile. "I thought I told you we all went informal up here," she chided mildly. "My name's Betsy."

"Oh . . . well . . . you called me 'Mr. Whitney' a while back, so I thought maybe that had changed." He looked a little embarrassed.

"Force of habit, I guess. Anyone wearing a three-piece suit looks like management to me. And as to your question, yes, I'm fine."

"You look tired. How long have you been flying?"

A chuckle made it halfway up her throat. "About twenty-six years, all told. This session, though, less than an hour and a half. I came on duty just before the shuttle crashed."

"Oh." His tone said he wasn't thoroughly convinced.

She looked at him again. "Really," she insisted. "What you're calling tiredness is just tension, pure and simple."

The corner of his mouth quirked. "Okay. I always *was* a lousy detective." The quirk vanished and he sobered. "What do you think their chances are? Honestly."

"It all depends on how fast we can get the shuttle secured—or how fast we find out we *can't* do it."

Whitney frowned. "I don't follow. Are you talking about the—" he glanced at his watch— "six hours of fuel the shuttle's got left?"

"Basically—except that it's only about five and a half now; we nudged his thrust up a notch in two of his engines a while ago." She turned to face forward again, lips compressing into a thin line. "We're in a very neat box here, Peter. You know the Skyport clockwise circuit, don't you?"

"Sure: Boston, New York, Philadelphia, Washington, Atlanta, New Orleans, Houston, Dallas, L.A., San Francisco, Denver, Kansas City, Chicago, Detroit, Cleveland, Pittsburg, Washington, then back up the pike to Boston." He rattled off the names easily, as someone who'd learned them without deliberate effort. "A twelve-hour run, all told."

"Right. Now note that once we secure the shuttle, there are exactly two places we can land with it: the Skyport maintenance facilities at Mirage Lake, near L.A., and the Keansburg Extension of New Jersey; and L.A.'s probably a half hour closer. *But*—" she paused for emphasis—"between here and L.A. there are no Skyport cities. Which means no shuttles. Which means any equipment we want to bring aboard to work with has to come from here. Which means we have to *stay* here until we're sure we've got everything we're going to need."

"Wumph." Whitney's breath came out in a rush, and for a moment he was silent. "But couldn't you head toward L.A. right away, circling there until you have the clamp fixed? Oh, never mind; you'll probably need the transit time to work. But wait a second—you could head back *east* now, toward New Jersey. Any extra stuff you needed could be brought up from Atlanta, or even Washington; you'd pass close enough to both cities on the way."

She'd had the same brilliant idea nearly twenty minutes ago, and had been just as excited by it as he was. It was a shame to have to pop his bubble. "The fly in that particular soup is John Meredith, the injured shuttle copilot. If we stay here and then manage to get him and the other passengers out within an hour, say, we can get him to a hospital a lot faster than if we had to wait till we reached Atlanta. That time could be life or death for him—and it's the uncertain nature of his injuries, by the way, that gives our box its other walls. Besides," she added grimly, "if we wind up losing the shuttle completely, I'd rather try and find an empty spot in

Arizona than in Pennsylvania to drop it into."

"Damn," he muttered. "You've thought through the whole thing, haven't you?"

"I hope not," she countered fervently. "Things don't look too good in my analysis. If I haven't missed something we're probably going to lose either an expensive shuttle or at least one irreplaceable life." She snorted. "Damn the FAA, anyway. We've been on their tail for at least two years now to push for a few more wing section-sized runways scattered among the major airports."

"Yeah, I've always thought it was a bad idea to leave thrust reversers off Skyport engines. The way things are now, you could lift a module off from a ridiculous number of runways that you couldn't put it down on in the first place."

"It's called economy. No one wants to build extra-big runways until they're sure the Skyports are going to catch on." She shook her head. "Enough self-pity. What's this project you mentioned?"

"Right. You said earlier that no one knew what sort of landing distance a wing section-shuttle combo would require. Well, I've done some figuring, and if I can use the combined computer facilities of two modules I think I can get you a rough estimate."

She blinked in surprise. "How?"

"My work for McDonnell Douglas has been on computer simulations for second-generation Skyport design. Most of it involves adjusting profile, mass, and laminar flow parameters and then testing for lift and drag and so on. I remember the equations I'd need and enough about module and shuttle shapes to get by. And it's not *that* complicated a program."

"What about the brakes and drogue chutes?" she asked doubtfully.

"I can put them in as extra drag effects."

Betsy frowned, thinking. There was no way the runways at Dallas would be long enough—of that she was certain. But . . . the figures would be nice to have. "Okay, if we can get two of the other wing sections to agree. You can't use Seven's computer; we'll need to leave it clear for the work down below."

"That's okay—I can link to the other systems and run everything from here."

Betsy turned toward the intercom. "Carl? What do you think?"

"It's worth trying. Two, Three—you've just volunteered your computers to Mr. Whitney's use."

It took Betsy a few minutes to show Whitney how to set up the two-system link, but once he got started he did seem to know what he was doing. She watched over his shoulder for a minute before returning to her seat. It was indeed a good idea, but she had to wonder why he hadn't simply called back his friend in Houston and had him run the program. With the—undoubtedly—larger machine there and the proper program already in place, they could surely have had the answer faster than Whitney could get it here. It was looking very much like he did indeed want an excuse to stay on the flight deck and observe the proceedings. She grimaced. The report he was presumably going to be

making to McDonnell Douglas wasn't likely to be a flattering one.

She shook her head to clear away the cobwebs. There were plenty of unpleasant thoughts to occupy her; she didn't need to generate any extra ones. And, speaking of unpleasantries . . . Steeling herself, she pulled her half-headset mike to her lips and switched it on. "Skyport to Shuttle. Status report, please."

"Oh, there's nothing much new here, Liz—just sitting around watching my copilot dying."

She'd been unprepared for the sheer virulence of Rayburn's tone, and the words hit her with almost physical force. Unclenching her jaw with a conscious effort, she asked, "Is he getting worse? Dr. Emerson?"

"He sure as hell isn't getting any better," Rayburn snapped before the doctor could answer.

Betsy held her ground. "Doctor?" she repeated.

"It's hard to tell," Dr. Emerson spoke up hesitantly. "He's still unconscious and his breathing is starting to become labored, but his pulse is still good."

"Well, we should at least have him out from under all that metal soon," Betsy told him. "The ground crew's aboard now, and they'll be bringing a torch aboard to cut the chair free."

"Yeah, I can see them climbing in down there," Rayburn said. "How do they expect to get up here?"

"Through your side window; I presume they brought a rope ladder or something with them. You'd better open up and be ready to catch the end when they toss it up."

"Hell of a lot of good it's going to do," the shuttle pilot growled. "How're they going to get him back out—tie a rope around him and lower him like a sack of grass seed?"

"If he's not too badly injured, yes," Betsy said, feeling her patience beginning to bend dangerously. "If not, we'll figure out something else. We're going to try and rig up a ski lift track from your window to the Skyport door to get the passengers out; maybe we can bring Meredith out that way on some kind of stretcher."

"A *ski lift track?* Oh, for—Liz, that's the dumbest idea I've ever heard. It could take *hours* to put something like that together!"

The tension that had been building up again within Betsy suddenly broke free. "You have a better idea, spit it out!" she barked.

"You've already heard it," he snapped back. "Let me take this damn bird down *now*, and to hell with ski tracks and nosewheel clamps. All you're doing is wasting time."

"You really think you can fly a plane with its nose smashed in, do you?" she said acidly. "What're you going to use for altimeter, autopilot, and gyros?"

"Skill. I've flown planes in worse shape than this one."

"Maybe. But not with a sprained wrist, and not with a hundred-sixty passengers aboard. And *not* while under my command."

"Oh, right, I forgot—Liz Kyser's the big boss here." Rayburn's voice dripped with sarcasm. "Well, let me just remind you, Your *Highness*, that I don't *need* your permission to leave your flying kingdom. All it would take is a simple push on the throttle."

Betsy's anger vanished in a single heartbeat. "Eric, what are you saying?" she asked cautiously.

"Don't go into your dumb blonde act—you know what I'm talking about. All I have to do is cut power and snap those last two collar supports and you can yell about authority all you want."

"Yes—and you'll either fall nose-down with the collar still around you or drop it onto someone on the ground." Betsy forced her voice to remain quiet and reasonable. "You can't risk innocent people's lives like that, Eric."

"Oh, relax—I'm not going to do anything that crazy unless I absolutely have to. I'm just pointing out that you don't have absolute veto power over me. Keep that in mind while you figure out how to get John to a hospital."

"Don't worry. We want him safe as much as you do." *Especially now.* "We'll keep you posted." Reaching over, Betsy turned off the mike.

For a moment she just sat there, her mind spinning like wheels on an icy runway. The flight deck suddenly felt cold, and she noticed with curious detachment that the hands resting on the edge of her control board were trembling slightly. Rayburn's threat, and the implied state of mind accompanying it, had shocked her clear down to the marrow. He'd always been loyal to the crews he flew with—it had been one of the qualities that had first attracted her to him—but this was bordering on monomania. Bleakly, she wondered if the accident had damaged more than Rayburn's wrist.

There was a footstep beside her. Whitney, looking sandbagged. "Betsy, is he—uh—?" He ran out of words, and just pointed mutely toward her half-headset.

"You heard, huh?" She felt a flash of embarrassed annoyance that he, an outsider, had listened in on private Skyport trouble.

Whitney, apparently too shaken to be bothered by his action, nodded. "Is he all right back there? I mean, he sounds . . . overwrought."

"He does indeed," she acknowledged grimly. "He's under a lot of pressure—we all are."

"Yeah, but you're not threatening to do something criminally stupid." He gestured at the intercom. "And why didn't Captain Young at least back you up?"

"He probably wasn't listening in—the radio doesn't feed directly into the intercom." She took another look at his expression and forced a smile she didn't feel. "Hey, relax. Eric hasn't gone off the deep end; he was just blowing off some steam."

"Hmm." He seemed unconvinced. "And how about *you?*"

The question caught her unprepared, and Betsy could feel the blood coloring her face. "I got a little loud there myself, didn't I?" she admitted. "I guess I'm not used to this kind of protracted crisis. Usual airplane emergencies last only as long as it takes you to find the nearest stretch of flat ground and put down on it."

"I suppose so. Anything I can do?"

"Yes—you can haul yourself back to the computer and finish that program."

Surprisingly, something in her tone seemed to relieve whatever fears he had about her, because the frown lines left

his forehead and he even smiled slightly. "Aye, aye, Captain," he said and headed aft again.

Well, that's him convinced. Now if only she could persuade *herself* as to Rayburn's self-control. Pushing the half-headset mike away almost savagely, she leaned toward the intercom. "Aaron, Paul—what's holding things up down there?"

The rolled-up end of thin rope smacked against the top of the window as it came in through the opening. Startled a bit by the sudden noise, Dr. Emerson turned his head—the only part of his body he could conveniently turn in the cramped cockpit—in time to see Captain Rayburn field the rope and begin pulling it in. Tied to the other end, its rungs clanking against the side of the shuttle, was a collapsible ladder, of the sort Emerson made his kids keep under their bunk bed at their Grand Prairie condo. He watched as Rayburn set the outsized hooks over the lower edge of the window and then turned back to his patient with a silent sigh of relief. At least the waiting was over. Now all he had to do was worry that Meredith was healthy enough to satisfy Rayburn—and *that*, he reflected darkly, was definitely a major worry. Rayburn's last stormy conversation with the Skyport had completely shattered Emerson's comfortable and long-held stereotype of the unflappable airline pilot and had left him with a good deal of concern. Searching the unconscious copilot's half-hidden face, Emerson wondered what it was about this man that had caused Rayburn to react so violently. Was he a good friend? Or was it something more subtle—did he remind Rayburn of a deceased brother, for instance? Emerson didn't know, and so far he hadn't had the nerve to ask.

"Okay, Doc, here they come." Rayburn, who'd been leaning his head partly out the window, began unsnapping his safety harness. "Let's get out of here and give them room to come in."

Emerson rose from his crouch, grimacing as his legs registered their complaint. Trying to look all directions at once, he backed carefully out of the tiny space, and made it out the cockpit door without collecting any new bruises. Rayburn was out of his seat already, standing in the spot Emerson had just vacated, shouting instructions toward the window. "Okay—easy—just keep it away from the instruments—okay, I've got it." Two small gas tanks, wrapped together by metal bands and festooned with hoses, appeared in his hands and were immediately tucked under his right arm. The second package was, for Emerson, far more recognizable: the big red cross on the suitcase-sized box was hard to miss. A moment later he had to take a long step toward the shuttle's exit door as Rayburn backed out of the cockpit. "Watch the controls!" he shouted once more as he set down his burden and reached back with a helping hand.

It took only a few minutes for them to all come aboard. There were three: two mechanic-types who set to work immediately turning the gas tank apparatus into an acetylene torch; and an older man who caught Emerson's eye through the small crowd and headed back toward the passenger section. Emerson took the cue and followed.

"I'm Dr. Forrest Campbell," the newcomer introduced himself when the two men reached the pocket of relative quiet at the forward end of the passenger compartment.

"Larry Emerson. Glad to have you here. You work for the airline?"

"Temporarily coopted only—and as the man said, if it weren't for the honor I'd rather walk." He nodded down the rows of ski lift seats. "First things first. Are the passengers in need of anything?"

"Nothing immediate. There are some bruises and one or two possible sprains. Mostly, everyone's just scared and cold."

"I can believe that," Campbell agreed, shivering. "I'm told the Skyport's come down to eight thousand feet, but it still feels like winter in here. I hope the next shuttle up thinks to bring some blankets. All right, now let's hear the bad news. How's the copilot?"

"Not good." Emerson gave all the facts he had on Meredith's condition, plus a few tentative conclusions he hadn't wanted to mention in Rayburn's earshot. "We'll have to wait for a more thorough examination, of course, but I'm pretty sure we're *not* going to be able to risk lowering him out that window at the end of a rope."

"Yes . . . and I doubt that a stretcher would really fit. Well, if we can get him stable enough he can stay here until the shuttle can be landed again."

"I guess he'll have to." A sharp *pop* came from the cockpit, and looking past Campbell he saw the room aglow with blue light. "I hope they're got going to fry him just getting him out," he muttered uneasily.

"They'll have attached a Vahldiek conductor cable between the part of the chair stem they're cutting and the fuselage, to drain off the heat," Campbell assured him. "Let's go back in; this shouldn't take long."

It didn't. They had barely reentered the exit door area—now noticeably warmer—and opened the big medical kit when the torch's hiss cut off. Rayburn stepped back from the doorway, muttering cautionary instructions as the unconscious copilot, still strapped into his seat, was carried carefully out of the cockpit.

"For now, just leave him in the chair," Campbell said as they set down the seat and disconnected the thin high-conduction line. Stethoscope at the ready, he knelt down and got to work.

Emerson stepped over to Rayburn. "Shouldn't you be getting back to the cockpit, Captain?" he suggested quietly.

Rayburn took a deep breath. "Yeah. Take care of him, Doc, and tell me as soon as you know anything."

"We will."

Stepping carefully around the figures on the floor, Rayburn went forward, and Emerson breathed a sigh of relief. At least the shuttle had a pilot again, should something go wrong with what was left of the docking collar. Now if only that pilot could be persuaded not to do anything hasty . . . He shivered, wondering if Rayburn would really rip the shuttle from its unstable perch . . . wondering if the Skyport's holding pattern was taking them over Grand Prairie and his family.

Pushing such thoughts back into the corners of his mind, he squatted down

next to Dr. Campbell and prepared to assist.

"All right, let it out again—real easy," the gravelly voice of Al Carson said in Greenburg's ear. Mentally crossing his fingers, Greenburg kept his full attention on the clamp arm as, up on the flight deck, Henson gave it the command to extend.

But neither Greenburg's wishes nor Carson's quarter-hour of work had made any appreciable change in the arm's behavior. As near as Greenburg could tell from his viewpoint by the access panel, the arm followed exactly the same path he'd seen it take earlier. It certainly came up just as short.

Carson swore under his breath. Once again he took the sheaf of blueprints from his assistant, and once again Greenburg gritted his teeth in frustration. Neither Carson nor the rest of his crew were experts on Skyport equipment—such experts were currently located only on the east and west coasts—but even so they'd identified the basic problem in short order: one of the four telescoping segments of the arm apparently was not working. That much Carson had learned almost immediately from the blueprints (and Greenburg still felt a hot chagrin that he hadn't caught it himself); but all the lubricating, hammering, and other mechanical cajolery since then had failed to unfreeze it. And they were running low on time.

"Hey, you—Greenburg." Carson gestured up at him. "C'mere and give us a hand, will you?"

"Sure." Gripping the line coming from his safety harness—a *real* safety harness; the ground crew had brought along some spares—he stepped up on the box they'd placed beneath the opening and wriggled his way through. He was most of the way into the bay before he remembered to check the space above him for falling debris, but Lady Luck was kind: none of the rest of the crew was working directly overhead. He gave their operation a quick once-over as the motorized safety line lowered him smoothly down the bay wall, and was impressed in spite of himself. The Skyport tunnel had been run out as far to the side as possible and locked in place pointing toward the open cockpit window, and already the first part of the ski lift framework had been welded between the tunnel and shuttle fuselage. A second brace was being set in place; two more, and the track itself could be laid down. It wouldn't take long; six men—fully half the group that had come up—were working on that part of the project alone. In Greenburg's own opinion more emphasis should have been placed on getting the clamp attached, but he knew it would be futile to argue the point. The crew took their orders from the airline, and the airline clearly had its own priorities.

He reached bottom and, squeezing the manual release to generate some slack in his line, ducked under the shuttle and headed over to where Carson and his assistant waited. "All right," the boss said, indicating a place on the clamp arm. "Greenburg, you and Frank are going to pull here this time. Henson? Back it up about halfway."

The arm slid back. Greenburg and Frank gripped the metal and braced themselves as Carson armed himself with a large screwdriver and hammer.

On his signal Henson started the arm out again, and as the other two pulled, Carson set the tip of the screwdriver at the edge of the segment and rapped it smartly with the hammer.

It didn't work. "Damn," Carson growled. "Well, okay, if it was the catch that was sticking that should have taken care of it. The electrical connections seem okay—the control lines aren't shorted. That leaves the hydraulics." He picked up the blueprints and started leafing through them. "Okay. We got separate lines for each segment, but they all run off the same reservoir. So it's gotta be in the line. You got any pressure indicators on these things up there?"

"We're supposed to," Henson replied. "But we seem to have lost them when the emergency collar went—"

"Wait a second," Greenburg cut in as his brain suddenly made a connection. "The hydraulic lines for the arm run by the emergency collar?"

"Yeah, I think so," Carson said. "Why?"

Lewis, listening from outside the bay, swore abruptly. "The broken hydraulic lines!"

"Broken lines?" Carson asked sharply. "Where?"

"Back there, by the emergency collar." Even as he said it Greenburg remembered that the ground crew had been brought into the cargo deck further forward, that they hadn't seen the pool of hydraulic fluid that he and Lewis had had to step over earlier. "There's leakage on both sides of the bay. Most of it's from the collar itself, we think, but some of it could be from the line that handles this segment. Couldn't it?"

"Sure could." Carson didn't look very happy as he found the schematic he wanted and glared silently at it for a moment. "Yeah. All the arm segment lines run separately all the way to the reservoir, it looks like, so that if one gives you've still got all the rest. They all run along the starboard side of the bay, right where the shuttle hit. Ten'll get you a hundred that's the trouble."

"Rick? How about it?" Greenburg called.

"Probably." Henson sounded disgusted. "I think the sensors are located in that same general area. You could probably track the line back visually and confirm it's broken."

"For the moment don't bother; it's not worth the effort," Betsy's voice came in for the first time in many minutes. "Mr. Carson, can it be fixed or will we have to replace the whole arm?"

"I don't know. Frankly, I'm not sure either one can be done outside a hangar. Leastwise, not by me."

"I see." There was a pause—an ominously long pause, to Greenburg's way of thinking. "I'd like you to look at the arm, anyway, if you would, and see how much work replacing it would take. Aaron, would you come to the flight deck, please? We need to have a consultation."

"Sure, Bets." He made the words sound as casual as possible, even as his stomach curled into a little knot inside him. Whatever she wanted to discuss, it was something she didn't want the whole intercom net to hear . . . and that could only be bad news.

Moving as quickly as he dared, he headed back under the access panel and, kicking in his harness's motor, began to climb the wall.

* * *

It was, to the best of Betsy's knowledge, the first time the closed intercom system had ever been used aboard a Skyport, and she found her finger hesitating slightly as it pressed the button that would cut Seven's flight deck off from everyone except Carl Young on Four. But she both understood and agreed with the Skyport captain's insistence that this discussion be held privately. "All set here, Carl," she said into the grille.

"All right," the other's voice came back. "I'm sure I don't have to remind either of you what time it's getting to be."

"No, sir." The instrument panel clock directly in front of her read 10:02:35 EST, with the seconds ticking off like footsteps toward an unavoidable crossroads. "At just about fourteen twenty-five the shuttle runs out of fuel. If we're going to reach Mirage Lake before that happens, we've got to leave Dallas right now."

"Or in twenty minutes, if we wind up running right to the wire," Greenburg muttered from the copilot's chair. A shiver ran visibly through his body; but whether it was an aftereffect of the cold air down below or a reaction to the same horrible image that was intruding in Betsy's own mind's eye, she had no way of knowing.

"True; but we don't dare cut things that fine," Young said. "We don't know how long those two collar supports will hold under a full strain. How is the forward clamp?"

"It's shot," Greenburg said succinctly. "One of the segments has a broken hydraulic line, we think."

"Replaceable?"

Greenburg hesitated. "I don't know. The ground crew boss doesn't think so."

"What about the escape system for getting the passengers out?"

"Proceeding pretty well. If no new problems crop up I'd say they'll be ready with the thing in half an hour or so."

"Well, that's something, anyway. Betsy, what's the latest on Meredith's condition?"

Betsy took a deep breath. "It's not good, I'm afraid. The doctors say he's got at least a couple of broken ribs, a possible mild concussion, and slow but definite internal bleeding. They've got him laid out on cushions in the shuttle's aisle and have asked for some whole blood to be sent up. I've already radioed the ground; it'll be brought by the next shuttle up."

Greenburg gave a low whistle. "That doesn't sound good at all."

"It's not," she admitted. "There's also evidence that some of the blood may be getting into one of his lungs. Even if it's not, putting new blood into him's a temporary solution at best."

"How long before he has to get to a hospital?" Greenburg asked bluntly, his eyes boring into Betsy's.

"The doctors don't know. At the moment he's relatively stable. But if the bleeding increases—" She left the sentence unfinished.

"Four hours to L.A. at this speed. That's a long time between hospital facilities," Young mused, and Betsy felt a stab of envy at the control in his voice. Ultimately, it was really Carl, not her, who was supposed to be responsible for

the safety of the Skyport and its passengers. What right did he have to be so calm when she was sweating buckets over this thing?

"Wait a second," Greenburg spoke up suddenly. "It doesn't have to be an all-or-nothing proposition. We could dock a shuttle in, say, Six and carry it with us to L.A. Then if Meredith got worse we could land him at any of the airports along the way."

"You're missing the point," Betsy snapped. The sharpness of her tone startled her almost as much as it did Greenburg, judging from his expression, and she felt a rush of shame at lashing out at him. "The problem," she said in a more subdued voice, "is that stuffing Meredith out that cockpit window and into a ski lift chair could kill him before we could get him down and to a hospital. The doctors didn't actually come out and *say* that they wouldn't allow it, but that was the impression I got. Given Rayburn's state of mind, I didn't want to press the point with him on the circuit."

"So what you're saying is that Meredith is stuck on the shuttle until it can be landed," Young said.

"Yeah, I guess that's basically what it boils down to," Betsy admitted. "Unless he takes a turn for the worse, in which case we'll probably have to go ahead and take the chance."

"Uh-huh." Young was silent for a moment. "All right, here's how things look from where I sit. I've been in contact with United, and they have absolutely insisted that getting the passengers out of the shuttle be our top priority —higher even than Meredith's life, if it should come to that. A second crew will be coming up with that shuttle you mentioned to help with the off-loading. The airline chiefs say they want—and I quote—'everyone safely aboard the Skyport with complimentary cocktails in their fists' within an hour." For the first time, Young's voice strayed from the purely professional as a note of bitterness edged in. Somehow, it made Betsy feel a little better. "What happens to Meredith and the shuttle is apparently *our* problem until then, when presumably they'll be willing to lend more of a hand."

"So what do we do?" Greenburg asked after a short pause. "Get everything aboard that we'll need for the ski lift track and hightail it for L.A.?"

"We also need to fasten the shuttle more securely before we go," Betsy said. "Rayburn wants Meredith in a hospital immediately if not sooner, and if we try telling him he's going to have to wait another four hours he may try taking Meredith's safety into his own hands."

Greenburg frowned at her. "What do you mean?"

"Oh, that's right—you didn't hear that little gem of a conversation." In a half-dozen sentences Betsy summarized Rayburn's earlier outburst. Greenburg's eyes were wide with shocked disbelief by the time she finished. "Carl, we've got to get him out of that cockpit before he flips completely," he said, his left hand tracing restless patterns on the armrest.

"On what grounds? He hasn't actually tried to *do* anything dangerous. He could claim he was just blowing off steam."

"But—"

"No buts." The Skyport captain was firm. "We can't justify it—and besides, how do you think he'd react to an order like that?"

Greenburg clamped his lips together, and Betsy thought she saw some of the color go out of his face. "That's a little unfair," she said. "We don't *know* that he'd react irrationally." It felt strange to be defending Rayburn; quickly, she changed the subject. "Anyway, we're getting off the point. The immediate issue here is whether or not we head west in the next fifteen minutes. Carl, I guess this is your basic command decision."

Young's sigh was clearly audible. "I'm afraid I don't see any real alternative. We're just going to have to gamble with Mr. Meredith's life. All of the ski lift track and auxiliary equipment we're using only exists at fields that handle Skyport shuttles. If the crew putting the escape system together runs short of anything halfway to L.A. they'll have no way to get extra material quickly. We have to stay here at least until all of that's completed."

Betsy nodded; she'd more or less expected that would be the way the decision would break. The airline was clearly going to keep up the pressure, and the ski lift track system was the only way to get that many passengers off with anything like the speed and safety United would be demanding.

"And after they're off?" Greenburg asked quietly.

"We'll head toward L.A. and hope we've either secured the shuttle by then or that the last two collar supports are stronger than they look."

"Yeah." Shaking his head, Greenburg got to his feet. "I hope to hell we're doing the right thing, Carl. I'm not convinced, myself."

"Me, neither," Young acknowledged frankly. "But I don't see what else we can do. If we should somehow lose the shuttle with the passengers still aboard . . . it's not something I want to think about."

Greenburg nodded, shifted his gaze to Betsy. "I'm going back down and lend a hand, unless you need me here."

"No, go ahead. And Aaron—sorry I snapped at you earlier."

"Forget it. We're all tense." His hand touched her shoulder briefly and then he was gone.

"Betsy?" a tentative voice asked from behind her as she switched the intercom back to normal and the buzz of low-level conversation abruptly came back.

"Yes, Peter, what is it?" she asked, turning her head.

"I've got the first results of my program now, if you're interested."

She'd almost forgotten about Whitney; he'd been so quiet back there. "Sure. Let's hear the bad news."

"Well . . . it could be off ten percent or so either way, understand; but the number I get is seven point eight kilometers."

She did a rough conversion in her head, nodded heavily. "About twenty-five four hundred feet."

"Close enough," he agreed. "I can probably get a more refined version to run before the shuttle passengers are off."

She shook her head. "Not worth it. The longest runway at Dallas is twenty thousand feet, and even if your numbers

are fifteen percent high we still would never make it.''

''Yeah.'' Whitney hesitated, a half-dozen expressions flickering across his face. ''You know, Betsy, this really isn't any of my business . . . but I get the impression you're upset with yourself for not being—oh, as cool and calm as maybe you think you should be. Is that true?''

Betsy's first and immediate reaction was one of annoyance that he should bring up such a personal subject. Her second was that he was absolutely right, which annoyed her all the more. ''How I feel about myself is irrelevant,'' she said, a bit tartly. ''I'm in command here; that requires me to be competent at what I do. Pressure like this isn't new to me, you know—I've been in crisis situations before.''

''But they haven't been like this one, I'll bet, because you're *not* really in command here—not entirely, anyway. That's where the trouble is.'' There was an odd earnestness in his face, as if it were very important for some reason that he get his point across to her. ''You see, if you were flying a normal airplane, you *would* be in complete control—I mean as far as human control ever goes—because all the buttons and switches would be under your hands alone. But *here*—'' he gestured aft, toward the shuttle—''here, even though you're still claiming all the responsibility for what happens, half of the control is back there, with Captain Rayburn. He's got a mind and will of his own; you can't force him to do what you want, like you can your engines or ailerons. Of *course* you're going to be under extra pressure—you've never had to *persuade* part of your plane to cooperate with you before! It's *normal*, Betsy—you can't let it throw you.'' He stopped abruptly, as if suddenly embarrassed by the vehemence of his unsolicited counsel. ''I'll shut up now,'' he muttered. ''But think about it, okay?'' Without another word he slipped back to the computer console.

Betsy leaned back in her seat, her thoughts doing a sort of slow-motion tumble. The last thing in the world she had time for right now was introspection . . . but the more she thought about Whitney's words, the more sense they made. Certainly Rayburn was only nominally under her control—his threats had made that abundantly clear—while it was equally certain that diplomacy and persuasive powers had never been among her major talents. Was that *really* the underlying source of her tension, the fact that she wasn't properly equipped for that aspect of the crisis?

Oddly enough, the idea made her feel better. She wasn't, in fact, getting old or losing her nerve. She was simply facing a brand-new problem—and new problems were *supposed* to be stressful.

For the first time since the shuttle crash, Betsy felt the tightness in her stomach vanish completely as all her unnamed fears, now robbed of their anonymity, scurried back into the darkness. If controlling Rayburn was what was required, then that was what she would do, pure and simple. All it took was strength and self-confidence—and both were already returning to her. She would have to thank Whitney later for his well-timed brashness. Right now, however, she had work to do. ''Greenburg?'' she called into the intercom

grille. "I've got a couple of suggestions on how you might fix that clamp."

Seen through the distorted view of a fisheye camera, the escape system apparatus resembled nothing more dignified than a jury-rigged carnival ride—but it worked, and it worked well, and that was what counted. Even as Betsy returned her attention to the monitor, a pair of legs poked out the cockpit window and, above them, a line and hook were handed up to the man leaning vertically along the windshield. Eye-level to him was the newly built ski lift track; into it he dropped the end of the hook. The hook immediately moved toward the passenger tunnel, and as the line tightened, the dangling legs bounced forward and out and became a business-suited man seated securely in a breeches-buoy type of sling. Even as he traveled toward the tunnel, an empty sling passed him going the other direction, and another set of legs poked tentatively out the cockpit window. Total elapsed time per passenger: about fifteen seconds. For all one hundred sixty of them . . . Betsy glanced at the clock and did the calculation. Maybe three or four left aboard now. And once they were off, a new confrontation with Rayburn was practically inevitable. Her throat ached with new tension as she tried to plan what she would say to him.

All too soon, the familiar voice crackled in her ear. "This is Rayburn. Everyone's off now except John and the two doctors. What's next?"

His harsh, clipped tone made the words a challenge, and Betsy felt the self-confidence of ninety minutes ago drain completely away. "We're leaving for L.A. in a few more minutes," she told him. "With the cable on your tow bar and the extra support of the escape system framework, the docking collar should hang on even after you run out of fuel."

"Who are you trying to kid, Liz?" The bitterly patronizing tone struck her like a slap in the face, and she felt her back stiffen in reaction. He continued, "I saw that so-called cable when they brought it in—it wouldn't hold for two minutes. And you're drunk if you think a little spot-welding along the fuselage is going to do any good at all."

Betsy opened her mouth, but no words came out. In smaller quantities, she shared his own doubts about the cable looped around the nosewheel and the end of the clamp; they'd done the best they could, but the clamp simply wasn't designed to handle a line of any real diameter. Heavier cables were available, but there weren't any good places to attach them, either on the shuttle or the inner bay wall. "There are other things we can try on the way," she said, getting her voice working at last. "A stronger line, perhaps run through the access panels we've been using." Though where the ends would be anchored she had no idea.

But Rayburn didn't even bother to raise that point. "Swell. And what about John—or don't you care if he bleeds into his gut for another four hours? What're you going to do, just keep pumping blood into him and hope the leaks don't get worse? Or maybe you're going to stuff an operating room in through the window?"

"And what do you think the shock

of landing will do to him?'' Betsy countered.

''He's got to land *some*time. Better now than later, when he'll probably be weaker.'' Rayburn paused, as if waiting for an argument. But Betsy remained silent. ''So okay, I'm going to take him down. I'll give you fifteen minutes to get rid of that cable and junk pile by my window; otherwise I'll just have to pull them out when I leave.''

Betsy swallowed. She had no doubt that he could indeed tear off the cable if he really worked at it—and the chances were excellent he'd damage his front landing gear in the process. And that would essentially be signing his death warrant, because even if he somehow managed to keep the crippled plane from diving nose-first into the ground, there was no chance whatsoever that he could control it accurately enough to safely belly-land on a crash-foamed runway. He had to know that; he couldn't be *that* far gone. But she didn't have the nerve to call his bluff. ''Eric, if you disobey orders like this you'll never fly again for any airline,'' she pointed out, trying to keep her voice reasonable. ''You know that, don't you?''

''I don't give a damn about the airlines or your tin-god orders—you should know me better than that by now. All I care about any more is John's life. Fifteen minutes, Liz.''

Stall, was all she could think of. ''We have to get Dr. Emerson off the shuttle first,'' she told him. ''You can't risk his life on this.''

Rayburn snorted impatience. ''All *right*. Doc! No, you—Doc Emerson. You're to get your things and leave; Skyport orders. Sorry, no . . . but, look, thanks for everything.''

The earphone went silent. Betsy pushed the mike away from her with a trembling hand. Whitney's earlier words echoed through her mind—but it did no good to recognize on an intellectual level that once Rayburn defied her instructions she was absolved from all responsibility for the shuttle's safety. Emotionally, she still felt the crushing weight of failure poised above her shoulders.

Because, down deep, she finally knew what the real problem was. Not theoretical concepts like command and responsibility; not even Rayburn's open rebellion.

The problem was her. *Leadership is what command is all about*, she thought, a sour taste seeping into her mouth. *A captain needs to* act; *but all I can do with Eric is* react. She should have seen it long ago, and recognized it as the one remaining legacy of their long-since-broken relationship. Then, for reasons that had seemed adequate at the time, she had allowed his overpowering personality to take charge, submitting to his lead in all things, until in its subtle and leisurely way a pattern had been set for all their future interactions. He acted, she reacted; a simple, straightforward, and unbreakable rule . . . and men would probably die today because of it. And even as she contemplated that consequence of her failure, a second, more brutally personal one drove itself into her consciousness like a thorn under a fingernail: for a year and a half Rayburn's name, face, and voice had been instant triggers of guilt-tinged pain to her . . . and if he died now, under these

circumstances, he would haunt her from his grave for the rest of her life. "No!" she hissed aloud, beating gently on the edge of her instrument panel with a tightly curled fist. The pattern could be broken; *had* to be broken. She couldn't afford to accept his assumption that no alternative solutions existed. Their lives, and her future sanity, could depend on her proving him wrong.

Gritting her teeth tightly together, she stared at the monitor screen, her eyes dancing over the broken shuttle, the inside of the bay, the inadequate cable. Somewhere in all of that there was an answer. . . . Dr. Emerson's legs appeared through the cockpit window, his hand groping upward with the hook until the man on the windshield took it from him and set it in place. The line tightened and the doctor popped out of the window, flailing somewhat with his carry-on bag as he swung in midair.

And Betsy had the answer. Maybe.

"Peter!" she called, spinning around in her chair. "Did you finish that second landing-distance analysis yet?"

Whitney looked up at her. "Yes—it came out a little better this time: about seven point seven one kilometers, plus or minus five percent, maybe."

"How much worse would it be on a foamed runway?"

He blinked. "Uh, I really don't know—"

"Never mind. Warm up the machine again; I need some fast numbers from you." She flicked on her mike again. "Eric? Hold the ceremonies; I've got an idea."

"Save your breath. Whatever you've come up with, I'm going anyway."

"I know," she said, smiling coldly to herself. "But you're not going alone. We're going to hand-deliver you."

The sky had been a perfectly cloudless blue when the Skyport first approached Dallas earlier that morning. Now, five hours later, it looked exactly the same, giving Betsy a momentary feeling of déjà vu. But the sensation faded quickly. The airport that was just coming into view through the flight deck windows was to the north of them this time, instead of to the west, and even at this distance the heavily foamed runway was clearly visible in the noonday sun. And the throbbing roar of the engines behind her was a powerful reminder that this time the silver giant that was Wing Section Seven was fully awake.

"Range, twenty miles," Greenburg said from the copilot's seat. "Sky's clear for at least five miles around us."

She nodded receipt of the information, her eyes tracing a circuit between the windows, the computerized approach monitor, and the engine and other instrument readings. They were barely six minutes from touchdown now, and the pressure was beginning to mount. For a moment she wished she'd accepted Lewis's offer to do the actual landing, which would have left her with Henson's task of coordinating operations with the shuttle. But Lewis had already put in a full shift when the accident occurred, and whether he would admit it or not he was bound to be getting tired. Besides, this gamble was Betsy's idea alone. If something went wrong, she didn't want anyone else to share in the blame. Or in the physical danger, for that matter—but there she'd

met with somewhat less success. Ordering Lewis and the rest of Seven's off-duty flight crews to join the passengers in moving across to Five and Six had resulted in a quiet but firm mutiny. They'd helped the flight attendants get the passengers moved out, but had then returned en masse to the lounge, where most of them had spent the rest of the morning anyway, out of the way of the on-duty crew but close by if needed. Betsy had groused some about it, but not too loudly; though she couldn't imagine what help they could possibly be, their presence was somehow reassuring.

And reassurance was definitely something she could use more of. "Eric, we're about four minutes away. Are you ready?"

"As ready as I'm going to be." Even half buried in the rumble of Seven's engines, Rayburn's voice sounded nervous, and Betsy felt a flash of sympathy for him. The shoe that had been pinching her all morning was now squarely on *his* foot. Not only was his plane going to be brought down by someone else while he himself had to sit passively by, but he was going to be essentially blind during the entire operation. "You just be sure to hold a nice steady deceleration once we hit the runway."

"Don't worry." Betsy stole a quick glance at the bay monitor. The escape system had been dismantled before Seven broke off from the rest of the Skyport, and the passenger tunnel retracted into the bay wall; the front landing gear, freed from the tethering cable, had been similarly retracted into its well. Betsy's jaw tightened and she winced at the thought of the shuttle hitting that foamed runway belly-first at a hundred-twenty knots. Rayburn would have a massive job on his hands at that point, trying to maintain control of his skid while bringing the shuttle to a stop. But there was no way around it—the shuttle couldn't leave the docking bay with its nosewheel extended, and with less than a six-foot drop from its docked position to the ground there would be nowhere near enough time to get the landing gear in position once the shuttle was out. She hoped to hell the airport people had been generous with the foam.

"Seven miles to go," Greenburg murmured. "Final clearance has been given. Speed at one-seven-five."

One hundred seventy-five knots—one statute mile every eighteen seconds; a good fifty knots higher than the shuttle's own landing speed—and even at that Seven was barely staying aloft. Betsy's mouth felt dry as she made a slight correction in their approach path. Not only did she need to put Seven down on the very end of the runway if they were going to have any chance of pulling this off, but the runway itself was only two hundred feet wide, barely thirty feet wider than Seven's wheel track. She needed to hit it dead center, and stay there . . . and all of its markings were hidden by the foam.

"Betsy!" Henson's voice crackled with urgency. "Rayburn's lowered his main landing gear!"

"What?" Both her hands were busy, but Greenburg was already leaning over to switch the TV to Seven's outside monitor . . . and Henson was right. "Rayburn!" she all but bellowed into

her mike. "What in hell's name do you think you're doing?"

"Trying to make this landing a little easier," he said, his voice taut.

"How?—by skidding into Dallas on your nose?"

"No—listen—all I have to do is control my exit from the bay so that my nosewheel is clear before I'm completely out."

"And then what—dangle by your nose until the wheel is down?" Betsy snorted. "Forget it. If you don't make it you could go completely out of control when you hit. Retract that gear, now."

"I can *do* it, Betsy—really. Please let me try."

For Betsy it was the final irony of the whole crisis; that Rayburn, having resisted her authority all morning, should be reduced to wheedling to get his way, even to the point of discarding the use of her hated nickname. But she felt no satisfaction or sense of triumph—only contempt that he would stoop to such shabby tactics, and bitter disappointment that he thought her fool enough to fall for something that transparent. And with sudden clarity she realized the reason for his new submissiveness: with Seven flying at such a low altitude Rayburn couldn't risk the unilateral action he'd hinted at earlier, because there was no way to guess whether or not the collar, once torn loose, would fall off fast enough for him to regain flying trim.

But it wasn't going to work. She was finally in command here, and nothing he could say or do was going to change that. If he didn't retract his gear as ordered she would simply pull out of her approach and circle the field until he did. This would be done her way or not at all.

Beside her, Greenburg shifted in his seat. "It's your decision, Betsy," he murmured, just loud enough for her to hear over the engines. "What do you think?"

She opened her mouth to repeat her order to Rayburn . . . and suddenly realized what she was doing.

She was still *reacting* to him.

It's your decision, Betsy. For the first time in years she really paused to consider what the words *decision* and *command* required of her. Among other things, they required that she dispassionately consider Rayburn's idea on its own merits, that she weigh his known piloting skill higher than his abrasive personality. And for perhaps the first time ever, she realized that accepting a good suggestion from him was not a sign of weakness. Perhaps even the opposite . . .

The airport filled the entire window, the foamed runway pointing at her like a sawed-off spear less than a mile away. "All right," she said into her mike. "But you damn well better pull this off, Eric. And do *not* jump the gun."

"Got it. And . . . thanks."

The individual undulations in the foam were visible now as the edges of the runway disappeared from her field of view. Betsy eased back on the throttle, remembering to compensate for the fact that the shuttle's extra length limited the attack angle she could use to kill airspeed just before touching down. The leading edge of the foam flashed past—and with a jolt the wing section was down.

"Chutes!" she snapped at Green-

burg, tightening her grip on the wheel as she braced for the shock. A moment later it came, throwing her roughly against her shoulder straps as the two drogue chutes on each end of the wing burst from their pods and bit into the air. Grimly, she held on, riding out the transient as she fought to keep Seven's wheels on the slippery runway. Within seconds the shaking had subsided from dangerous to merely uncomfortable, and Betsy could risk splitting her attention long enough to ease in the brakes. The straps dug a little deeper into her skin as the wheels found some traction. But it wasn't nearly enough, and she knew at that moment that Whitney's numbers had indeed been right: there was no possible way for Seven to stop on this runway. She could only hope the other numbers he'd worked out for her were equally accurate.

Through the vibrational din she could hear Greenburg shouting into his mike: "One-sixty . . . one-fifty-five . . . one-fifty . . ." Seven's speed, decreasing much too slowly. Betsy gritted her teeth and concentrated on her steering, trying to ignore the trick of perspective that made the end of the runway look closer than it really was. There were no shortcuts that could be taken here; if Seven was moving faster than a hundred-twenty knots when they released the shuttle, the smaller aircraft would become airborne, with the disastrous results she was risking Seven's crew precisely to avoid.

". . . one-forty . . . one-thirty-five —get ready—"

A sudden thought occurred to Betsy. "Eric!" she shouted, interrupting Greenburg's countdown. "Just before we release the collar we'll cut all braking here—that'll give you a constant speed to work against instead of a deceleration. You copy that, too, Rick?"

"Roger. Cue me, will you?"

"Right. Aaron, drop the chutes at one-twenty exactly."

"Roger. One-twenty-five . . . three, two, one, *mark!*"

There was no jerk this time, just a sudden drop in shoulder-strap pressure as one of the discarded drogues flashed briefly across the outside monitor screen. Simultaneously, Betsy released the brakes, and Seven was once again rolling free. "One-nineteen," Greenburg sang out.

"Collar!" Betsy snapped to Henson—and for the first time since touchdown gave her full visual attention to the monitor screen.

It was probably the finest display of engine and brake control that she had ever witnessed. Released abruptly from all constraints, the shuttle's tail dropped the short distance to the runway, landing on its main gear with a bump and splash of foam that made Betsy wince. At the same time the shuttle slid backward across the screen, as the extra air drag on its less aerodynamic shape tried to pull it out of the bay. But almost before the sliding began it was abruptly halted as Rayburn, with a touch even more skillful than Betsy had expected, nudged his engines up just exactly enough to compensate. She watched, fascinated, as the shuttle drifted back another few feet and again halted. There it sat, balanced precariously by its battered nose on the docking bay rim, its wheels and engines kicking up foam like mad, while its nosewheel—finally clear of the bay's confines—descended and locked in place.

And then, with one final lurch, the shuttle vanished from the screen.

"He's free!" Henson shouted unnecessarily. A tower controller, his voice a bare whisper in Betsy's ear, confirmed it, adding something about the shuttle being under good control as it braked . . . but Betsy wasn't really listening to him. Ahead, barely a mile of runway was left to them—just thirty seconds away at their current speed . . . and there was no way on Earth for them to stop before they reached it.

But Betsy had no intention of stopping. Instead, she opened the throttle all the way, and with a thunderous roar that drowned out even the rumble of landing gear on tarmac, the giant plane leaped forward, pushing Betsy deeply back into the cushions of her seat. Beside her, Greenburg would be calling off the speed increments; but she couldn't hear him, and she didn't dare take her eyes from the window to check the numbers for herself. She could see the end of the runway rushing toward her, and unconsciously she braced herself for the terrible crash that would signify that her gamble had failed. The edge of the foam swung at her like a guillotine blade —passed beneath her—

And the crash didn't come. Instead, the barren ground at the end of the runway flashed by, visibly receding below.

They'd done it!

Betsy let Lewis and Greenburg handle the routine business of flying Seven back to link up again with the rest of the Skyport. The two had insisted, and Betsy's hands were shaking so much from delayed reaction that doing it herself would have been difficult. Besides, a sort of celebration had erupted spontaneously in Seven's crew lounge, at which the wing captain's presence was being demanded.

What with the flurry of congratulatory hugs and handshakes and the general babble of tension-releasing conversation, Betsy missed the exact moment when the link-up occurred; her first real indication that Seven was back with the Skyport was the two grinning figures that strode unexpectedly into the lounge.

"Hey, Carl!" the first person to spot them shouted, waving a dangerously full glass. "Join the celebration!"

"Sorry—I can't spare the time," the Skyport captain said, speaking just loudly enough to penetrate the racket. "I just came by to congratulate Betsy in person. Mr. Whitney seems to think he's earned the right to do likewise."

"Thanks," Betsy called, handing her glass of fruit juice—she *was* on duty, after all—to the nearest bystander and making her way through the crowd. "Hang on a second—I want to talk to both of you."

She led them out into the hallway, where normal conversational levels would be possible. Once outside the din she turned to Young; but he'd already anticipated her first question. "I just talked to the tower," he said, "which had been in contact with the hospital. The landing did some extra damage to Meredith's internal bleeding problems, but with the ambulance and emergency room personnel standing by they think they got him in time. I'm also told, though very unofficially, that he probably wouldn't have made it if we'd tried to take him to L.A. instead."

Betsy let out a breath she hadn't re-

alized she'd been holding. They really *had* done it; they'd gambled Seven, the shuttle, and a lot of lives, and had won back all of it.

Young was still talking. "We're moving your passengers back in for the moment, though of course they'll have to leave again before we reach L.A. I've talked to McDonnell Douglas and United, and they'll have another wing section ready to replace you when we arrive. This one was due to go in for routine maintenance next month, anyway; you'll just be a little early." He harrumphed. "The United man I talked to seemed a bit concerned that you'd be landing with your corner drogues missing. I told him that anyone who can do a touch-and-go with a flying football field wasn't someone he needed to worry about."

She smiled. "That's for sure. After today, landing at Mirage Lake will feel like aiming to hit Utah. No problem."

"Well, at least you've got your confidence back," Young said, smiling in return. "I had been wondering about that earlier."

"Me, too," she admitted. "Which reminds me . . . Peter, I owe you a vote of thanks for that pep talk on command and responsibility you gave me a few hours ago. I don't know if it really made sense to me at the time, but it was just what I needed to break up the gloom and panic I was digging myself into."

Whitney actually blushed. "Yeah, well . . . I felt a little strange playing psychiatrist but . . . well, I had to say *something*. I was getting pretty worried about Captain Rayburn, and, frankly, I was scared to death you were going to go off the same end of the pool—no offense."

"No offense," Betsy assured him. "I can't honestly say that I wasn't a little worried about it myself." She shook her head, turning serious. "I still can't believe Eric went so badly to pieces. I know he was worried about Meredith's safety, but he was getting practically obsessive about it. He'll be *very* lucky if United doesn't boot him out for insubordination."

Young cleared his throat self-consciously. "Actually, Betsy, I suspect his flying career is over anyway. I haven't got any proof yet, of course, but I'll wager any sum of money that when the shuttle's flight recorder is played back it'll show that Rayburn had his automatic approach system off and was flying manually when the crash occurred. He's docked like that before, I'm pretty sure, and if we hadn't hit that patch of turbulence he might have gotten away with it this time, too."

Betsy felt her eyes widen in disbelief . . . but even as she opened her mouth to argue, all the puzzling parts of the incident suddenly made sense, and she knew he was right.

"But isn't that dangerous, not to mention illegal?" Whitney asked.

"Highly," Young told him, answering both parts of the question. "Even with an empty shuttle, which is how I gather he usually does it. Whatever possessed him to try it with a full passenger load I'll never know."

Betsy's lip curled, ever so slightly; but she held her peace. A figurative rape, perhaps? Or just an overwhelming desire to prove in her presence that he was a superior pilot? It didn't really matter; either way, it told her something

about Eric Rayburn that she had never suspected.

"Anyway, as long as that's just my unsupported opinion, I'd appreciate it if you'd both keep it to yourselves," Young was saying. "Betsy, I've got to get below now, help ease any ruffled feathers among the passengers. Congratulations again on your fine job here." With a nod to Whitney, the Skyport captain headed off down the hall.

Betsy watched him go, but without really seeing him. *So it comes full circle*, she thought bemusedly. *I fight to quit reacting to Eric, and find out he's been reacting just as blindly and irrationally to me*. She shook her head minutely. *Puppets, all of us—even all the ones who think they're mavericks. Puppets pulling on each others' strings.*

"I suppose I should go back down, too," Whitney said, breaking into her thoughts. "It was really a privilege to watch you in action, Betsy—thanks for letting me be part of it."

"Just a minute, Peter," she said as he turned to go, pushing the growing bitterness determinedly from her mind. After all, she was only forty-five—far too young to become a cynic. "I seem to recall you were interested earlier in a tour of the Skyport topdeck. That still true?"

"Uh, yes," he said, an uncertain smile playing around his lips. "If it's not too much trouble."

"No trouble at all." And besides, reacting with cynicism would just be giving Rayburn one final victory over her. "Come on, we'll start with the crew lounge. Drinks are on the house—and I understand the fruit juice is excellent today." ■

IN TIMES TO COME

Our next issue leads off with something you don't see too often: a funny serial. You might guess from its title, *Rails Across the Galaxy,* that it's a bit more light-hearted than our average novel, especially if you heard that it was written by Andrew Offutt and Richard Lyon. But you'd be only partly right; it's not *completely* frivolous. The central concept is quite as outrageous as it sounds, but Lyon, a research scientist when he isn't writing things like this, has given it a surprisingly solid scientific foundation. And it raises some pretty big issues, about which a good deal of thought-provocation is woven right into the fun. Kelly Freas is doing the illustrations.

the reference library

By Tom Easton

Long Shot for Rosinante, A.A. Gilliland, Ballantine/Del Rey, $2.25, 181 pp.
The Morphodite, M.A. Foster, DAW, $2.75, 224 pp.
Roderick, Volume 1, J. Sladek, Timescape, $2.75, ? pp.
Second Nature, C. Wilder, Timescape, $2.75, ? pp.
The Lost and the Lurking, M.W. Wellman, Doubleday, $10.95, 179 pp.
Isaac Asimov Presents The Great SF Stories 6 (1944), I. Asimov and M.H. Greenberg, eds., DAW, $2.95, 368 pp.
More Wandering Stars, J. Dann, ed., Doubleday, $10.95, 180 pp.
Footprints on Sand, L. Sprague and Catherine Crook de Camp, Advent, $12.00, 327 + xxii pp.
The Development of Astronomical Thought, P. Moore, Ian Henry, £4.95, 108 pp.
The Night Sky, R. Grossinger, Sierra Club Books, $16.95, 481 pp.
Cosmologies of Consciousness, E.C. Barksdale, Schenkman, $16.50 cloth, $11.25 paper, 139 + viii pp.

There don't seem to be any freight trains in my immediate future, folks. I didn't get that Legislative Assistant job. I'm still looking, but we'll just have to wait and see.

Even without freight trains, though, a column can sometimes be hard to get done on time. My deadline is two days away as I *start* this. I *was* all set to begin a week ago. All the term papers were read and graded. My desk was clear, and I had a stack of notes. But, my butt hurt too much to sit down.

Go ahead. Laugh, damn you! But it did! And after four days of increasingly excruciating pain, it was diagnosed as a large perirectal abscess. The diagnosis was quite sharp, too. The doc stuck a needle full of novocaine in my most fundamental tenderness. Then, while I was prying my fingernails out of the cracks in the ceiling, he said, "Hmm. Pus. We'll have to put you to sleep."

The ride into the operating room was lightened when a green-masked face loomed over me and cried, "Dr. Easton!" 'Twas one of my former biology students from the nursing program, and seeing her actually made me forget my fix for a moment. Fortunately, she didn't take advantage of her helpless prof, at least while he was awake.

After four more days recuperating in the hospital, I made it home, still sore, but eager to get to my desk and this moment. And if you think the last few paragraphs can't be made to fit into a book review column, at least in a general way, let me show you:

My experience vividly demonstrates the triteness of most literary torture scenes. Writers are anything but creative with the traditional glowing irons, scalpels, pincers, and crushers, even with the more modern electrodes and water hoses. Yet experience can suggest alternatives both simpler and more horrible. For instance, how about a single nether application of the red-hot poker, or a small injection of pus (here, have some!)? Wait a day or two for the swelling and tenderness to build, and then put a pinch of pepper up the victim's nose. The ensuing sneezes will feel like firecrackers and have all the effect any torturer could wish. I *know!*

Writers who wish to be truly original, however, must now come up with something different. I've preempted the creativity in that one. And now to books.

Alexis Gilliland's **Long Shot for Rosinante** is as appealing as any book can be that begins with a Moral Majority President wasting the Texas governor with a cruise missile. The MM reached the top via classic tactics, among which was a terrorist hit squad aimed at those who insisted on believing in evolution and doing genetic research, the Contra Darwin. Now the evolutionists are underground; some of them have moved off-planet; and the best of the lot, the machine-intelligence version of the murdered Susan Calvin (ring a bell?), is on its way to Rosinante, a space-habitat among the asteroids. The aging remnants of the Contra Darwin go on the warpath again, even as other forces lead to revolution. An intelligent missile ("This missile is satisfied to be of use") is shot toward Rosinante. Rosinante rushes a super-laser into action. And the showdown approaches.

It's wry. It's witty. It's pungent. It repeats things worth repeating about human foolishness. And it's a good read, very much in the *Analog* tradition.

M.A. Foster's **The Morphodite** concerns a world dedicated to avoiding change, to preserving "the good old days" forever. Yet there are those whose druthers lead them to the quintessence of change. By various training, surgical, and biochemical techniques, the Mask Factory turns criminals, misfits, and dissidents into the State's storm troopers. For the story, it has outdone itself, producing from an old-decrepit woman a middle-aged male genius who develops an analytic system that lets him identify the one person who is the keystone of a society. Trained as an assassin as well, he is to be given to the rebels as a weapon against the State. His creators think that, when the rebels reveal themselves by stepping forward to claim power after the assassination, they will catch them all and hence serve the status quo. But the keystone is not obvious, and when he is killed, things work out as foreseen by no one but the morphodite himself. His predictive power, you see, is not as spurious as his creators thought.

As an assassin, the morphodite has

a unique advantage. Once his crime is done, he need only hole up and trigger the change that made him from an old woman in the first place. He will become still younger, a woman again, and the change will extend even unto his genes (Foster said it, not I). His creators expect the change will cost him all memory, but that is not so. He retains, he plans, and when he changes for the last time, it is to achieve an exemplary idyll.

This book is *not* an easy read. The style is more than a little turgid, and events move slowly. But it is thoughtful, contemplative if you will, perhaps reminiscent of Vance. And it deserves attention—though the morphodite *is* a very unlikely creation.

John Sladek has begun a three-volume epic *cum* study *cum* soap opera centered on what it is to be human and what it is to be a machine—or, growing up in America. So far, we have **Roderick: The Education of a Young Machine, Volume 1**, and it looks good. Sladek spares no one. He is merciless in his waspish attacks on educators in the persons of elementary school teachers and university faculty, on cops, on counter-cultural fad-lovers, on people in general. He seems to reserve his regard for those who both love their work and can laugh at it, but even with them his view is a mite jaundiced; he has a lovely pair of characters in Ma and Pa Wood, Roderick's foster parents, dilettante artist and inventor, penultimately futile and impactless. He cares most for those who, though they try and try to comprehend the world, find only confusion. Such is his hero.

The story begins with a NASA employee who is mad for antique planes. To fund his habit, he devises a scam involving dummy corporations, inflated invoices, and orders that researchers whose projects he oversees follow certain "security" procedures. Caught, he suicides, leaving Project Roderick at the University of Minnetonka incomplete, fundless, its researchers accused of complicity in fraud. The Project's aim was to produce a robot. It is near success, and as work closes down, and as an anti-robot hit man stalks the team, its people take their "thinking" programs, put them in a mobile body—a small dome on tank treads—and mail Roderick off to distant friends.

There Roderick learns speech—and more—from TV. He gets shipped again, to the Woods, gets kidnapped by gypsies, returned, enrolled in school, expelled, shifted to a parochial school, and on and on. He learns, he questions, he gets confused, and the reader soon enough begins to wonder whether metal or meat a true machine makes. This seems to be Sladek's intent: to consider our ideas of mechanism. We like to think that machines are limited, that only people can consider and pick among multiple alternatives, but he shows us people whose responses are far more reflexive than a machine's, and a machine whose responses are much more what we think our own to be. Even the Woods, the sort of folks who do to their fellows the equivalent of setting armyworms to following the leader around a starve-to-death circle, he shows to be acting from reflex, not judgment.

Just where this series is going to go is impossible to say, but it is sure to be worth keeping track. I look forward to volumes 2 and 3, when Roderick will have a pink plastic humanoid body.

A year or so ago, Cherry Wilder published "A Long, Bright Day by the Sea of Utner" in one of the original anthologies. It was a good story, concern-

ing men's discovery of the Vail, immense intelligent sea creatures of the world Rhomary. The Vail are long-lived, and one returns to the same isle every few years for a day's conversation with one man and his descendants. To men, the talk spans generations. To the Vail, it is but a moment.

That story is now the prologue to a novel, **Second Nature**. A drought has driven the Vail away. Men struggle to rebuild the civilization of their star-faring ancestors. And a starship comes down in pieces.

The search is on: for metal, for artifacts, for survivors. It succeeds, and in the process it shows us strange aliens, the last Vail, and ourselves in light of ground-bound past and celestial future. One of Wilder's main concerns seems to be the value of pure information, and it is embodied in her protagonist, Maxim Bro, who holds the post of Dator, official data-gatherer. She is not, however, didactic, but dramatic and poetic, and her story is a pleasure to read.

Manly Wade Wellman's latest is **The Lost and the Lurking**, in which the government sends Silver John to investigate the hamlet of Wolver. Wolver turns out to be a hotbed of genuine witchcraft involved in an international conspiracy of evil, and John (of course) defeats its plans. Yet he does so only with the aid of a talisman which, though he has had it in past stories, here seems too contrived. It is a ragged little book, *The Long Lost Friend*, whose simple possession protects its bearer against all manner of magical evil. Yet John remembers this cardinal virtue only in the nick of time. Through most of the story, the book resides in his pack, stashed in the bushes.

I quibble, yes. One does not read Wellman for rigors of plot, but for flavor, for Appalachian color and the sound of old ballads, and *that* is all here. It's a treat.

I haven't been paying much attention to the *Isaac Asimov Presents The Great SF Stories* series. But here is **IAPTGSFS 6 (1944)**, and I can't resist. This one is for the year of my birth, and Stan Schmidt's, and George Lucas's, and Katherine Kurtz's, and David Gerrold's, and Jack Chalker's. It was a good year for stories, too. Asimov and Martin Greenberg were able to pick several installments of Simak's *City*, plus stories by van Vogt, Brackett, Leiber, Sturgeon ("Killdozer"), del Rey, and more. Perhaps most notable of all, though not for literary quality, was the story that gave *Astounding*'s reputation for prophecy its greatest boost—Cleve Cartmill's "Deadline"; that one brought U.S. intelligence agents into Campbell's office, asking, "Who leaked? Who told *you* how an A-bomb works?" You've heard the tale, I'm sure; it's really better than the story itself.

You may gather from my words that this series appeals to readers mostly on an age basis. Each volume may well sell largely to readers born in the year of that volume. In that way, it is like the front-page offers you see advertised periodically ("What did the *Times*/*Post*/etc. say on *your* birthday?"). There's nothing wrong with that at all, but it does limit the series' life. In a few years, it will be looking like just another "Best of the Year."

A few years ago, Jack Dann gathered together a book's-worth of Jewish SF stories as *Wandering Stars*. Now, with **More Wandering Stars**, he's done it again, repeating his demonstration of the immense variety available in one ethnic subgenre. Try Harvey Jacobs's

"Dress Rehearsal" vs. Barry Malzberg's "Leviticus in the Ark"; Joe Haldeman's "Mazel Tov Revolution" vs. Cynthia Ozick's "The Pagan Rabbi"; Dann's own "Camps"; Harlan Ellison's "Mom" . . . Some funny, some tragic, some depressing, all good.

In June 1981 L. Sprague and Catherine Crook de Camp were guests of honor at Milwaukee's X-Con. In honor of the occasion, the con committee prepared a sampler of their work, containing bits of fiction, poetry, and nonfiction by both de Camps. The sampler is **Footprints on Sand**, and it is indeed a lovely demonstration of the de Camp versatility, a testimonial to a rare marriage, and a tribute. There are words of praise from Heinlein, Carter, Asimov, Anderson, and more. There is biography and autobiography. There is sheer delight for every fan of either (or both) of the de Camps. Trouble is, Advent only printed 1500 copies. If you want one, I expect you'll have to holler for a reprint. Do.

Now I have three nonfiction books that tie curiously together. First is Patrick Moore's revision of his 1969 **The Development of Astronomical Thought**. It is a straightforward, unexciting review of its titular topic. Beginning with the ancient idea of human centrality to the universe, it traces the change to our present idea of human irrelevance. Its focus is on changing perspectives, viewpoints, and scales, and it achieves its end without dramatics (it almost entirely ignores the latest in black holes, gravitational lenses, neutrino mass, and so on). It is dry and dusty. Its great value is its brevity.

The Night Sky, by "cultural anthropologist" Richard Grossinger, on the other hand, tries to do a similar thing, but with little except dramatics. It is anything but dry, and it is hardly brief. Yet it will surely appeal to many, for Grossinger tries to conceive a cosmos in which the facts of science and the delusions of mysticism are simultaneously and equally true.

Grossinger looks at the sky and feels the brevity and smallness of life. When I look, I see an ocean on which we are about to embark and feel the grandeur of life. Does the difference lie in fear? Or in hubris? Grossinger seeks life's meaning or context outside the self, saying, "We require context" (p. xi). I prefer to believe we are our own context, we give meaning to what we perceive; and here Grossinger and I meet, for he too says the key to meaning lies in what the perceiver brings to the perceived. But he gives myth and science equal status, and the stars themselves are no more than a metaphor and a frame for his search. He tries to synthesize "New Age" astrology, as history and process and even truth, and astronomy, but it works only for the nonrationalist.

I find it hard to read Grossinger, for though he often makes sense, and he often says things worth saying, he is credulous too, and I constantly want to argue. His recounting of the Dogon/Sirius connection is selectively incomplete. He quotes frauds such as Crowley and Gurdjieff with respect. He believes in astral bodies. (See Camp's *The Ragged Edge of Science* for the straight dope.) He says, "The malaise of industrialism is taken as exactly Western man's loss of his own sources and his concomitant failure to credit astral intelligence with its role in civilization . . ." (p. 112) and "Astrology is . . . a science in the mathematical sense. . . . Modern physics . . . could not challenge the basic algebra of chart-making and planetary relationships" (p. 235) (as if technique

alone defines science!). And more. You see my difficulty, I'm sure.

Perhaps it's best if we call Grossinger a poet and view his work as a bridge of sorts between two cultures, a bridge built from the mystic's end. It may well serve such a purpose. But I would warn you not to be misled by the title, nor by the subtitle, "The Science and Anthropology of the Stars and Planets." Grossinger's book is most definitely *not* for serious, rationalist students. Yet —Moore's little book would have been much the better for more attention to the role of mysticism in the development of astronomical thought.

The third, and the last book for this month (I'm still not sitting comfortably), is E.C. Barksdale's **Cosmologies of Consciousness**. Barksdale is a professor of Germanic and Slavic literature at the University of Florida. He has published previously on literary structuralism and on the neuropsychological basis of human imagination. And I don't particularly want to read more by him. He seems a sloppy thinker, for in speaking of the Big Bang he refers to its residual sound, apparently confusing what comes out of a speaker hooked to a radio noise with sound, showing the jargon confusion of one out of his field and suffering for it.

But what is he trying to do? His subtitle is "Science and Literary Myth in an Exploration of the Beginnings and Development of Mind." He considers the evolution of life and language, and he discusses mythic accounts of the arrival of self-consciousness. He links myth and science and calls for a joint attack on the mind-body problem. He connects to *The Night Sky* with "the ultimate reality for humans is always symbolic . . ." (p. 49). He shares Grossinger's goal.

Yet in discussing the development of consciousness, he ignores most of the work that has been done with signing chimps and gorillas and with other animals. His account of brain development is 'way off. And he is capable of such mind-bogglers as: "Since facts are usually not objective, it follows that it is impossible to treat them objectively" (p. 47).

I could go on. I won't. Suffice it to say once more that the two cultures cannot be bridged by people who cannot speak the languages of both cultures. If a scientist such as Moore is more successful than a Grossinger or a Barksdale, it must be because his language is simple and clear enough to be followed by all; but few will read him, for he is dry. We can put more hope in the writers of SF, for they often make themselves understood in both cultures, in those cultures' own terms, for they blend rationality and mysticism with the excitement of story. ■

The annual meeting of the Science Fiction Research Association will be July 8-11 at the University of Kansas, in connection with the Sixth Annual Intensive English Institute on the Teaching of Science Fiction. Theme of the meeting, sponsored by the University and the Department of English, will be "Turning Points: New Directions for Science Fiction in Academe." Participating authors will include James Gunn, Frederik Pohl, Theodore Sturgeon, Harry Harrison, and others. More information is available from Stephen H. Goldman, Conference Director, Department of English, University of Kansas, Lawrence, KS 66045.

brass tacks

Dear Mr. Schmidt,

I expect better of *Analog*. I am willing to stretch a few points here and there, to suspend my disbelief once or twice, even to accept total nonsense in the pursuit of a good story. But with "The Trelph Is A Solitary Creature" by Thomas R. Dulski in your December 1981 issue, there is no hope of salvation. The author has presented enough logical and scientific sillinesses . . . well, I'd need a week of work to list them all. It is obvious that someone wasn't performing in an editorial capacity either. NONE of the anomalies were beyond redemption; a little work and a LOT of rewrite could have fixed it up.

The final straw, the last word in literary (science fiction literary!) incompetence, is to suppose that someone is going to pack up the wastes of a nuclear plant, transport them into space, and dump them on another habitable planet (p. 38)! Aside from the economics of transporting waste through INTERSTELLAR SPACE (why?), who of your readers is going to believe that the galaxy is so crowded that poor Priam IX is the only place to dump "high activity fissile waste" that's "loaded with plutonium"? And from a planet that has "billions of tons of high-grade uranium ore"? Come on!

This is obviously not just the author's problem. The editing on the story might have concealed his grammatical errors, but who was responsible for sorting through the science? Tighten up! Given the extensive room that *Analog* devotes to scientific controversy, along with your own editorial on ecology in the same issue, I find it hard to understand how anyone could have let this slip by.

ERICK A. WUJCIK

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Detroit, MI 48231

I hate to disappoint you, but we did *do our homework—both author and editor. One of the things I liked about "The Trelph . . ." is that it contains a good deal of science which obviously* can't *be right—but is. I didn't believe it either when I first saw the story, so I asked the author if he could defend it; he responded with six pages of careful calculations in which I could find no error.*

As for not believing that governments or industries will not do uneconomical, dangerous, or otherwise peculiar things, even on a quite large scale, I can only assume that you don't read newspapers (or history).

Dear Mr. Schmidt:

Could you please, please, please ask messieurs Tim Poston and Ian Stewart to supply a more detailed bibliography of references used in their article, "Rubber Sheet Physics" (November 9, 1981 *Analog*)?

T. JACH

Carbondale, IL

The author replies . . .

CHAOS: Douglas Hofstadter, "Metamagical Themas," *Scientific American* November 1981; R.M. May, "Mathematical aspects of the dynamics of animal populations," *MAA Studies in Mathematics* 16, 1978; R.M. May, "Biological populations with nonoverlapping generations: stable points, stable cycles, and chaos," *Science* 186 (1974) 645-647; J. Guckenheimer, G. Oster, and A. Ipaktchi, "The dynamics of density-dependent population models," *Journal of Mathematical Biology* 4 (1977) 101-147.

CATASTROPHE: T. Poston and I.N. Stewart, *Catastrophe theory and its applications*, Pitman, Boston 1978; P. Saunders, *An Introduction to Catastrophe Theory*, C.U.P. 1980; I.N. Stewart, "Applications of catastrophe theory to the physical sciences," *Physica 2D* (1981) 245-305; W. Güttinger and H. Eikemeier, *Structural Stability in Physics*, Springer, Berlin and New York 1980 (also has material on chaos).

SOLITONS: H.J. Bernstein and A.V. Phillips, "Fiber bundles and quantum theory," *Scientific American*, July 1981, 122-137. (This emphasizes the topology but not so much the solitons! Claudio Rebbi, in a fairly recent *Scientific American*—which I regret I can't lay hands on—had a solitons article that didn't emphasize the topology!) R.K. Bullough, *Solitons, Interaction of Radiation with Condensed Matter Vol. I*; International Atomic Energy Authority Report IAEA-SMR-20/51.

These also contain bibliographies leading to further possibilities for more reading.

Incidentally, may I take the opportunity to correct a misprint in the article? The formula 4x(1-x) has two x's and no multiplication signs; it is not 4 × (1-x).

IAN STEWART

Dear Dr. Schmidt,

I read with interest "Base Eight Arithmetic, Meteors and Man" (December 7, 1981 *Analog*) up to a point. That point was when the article shifted from arithmetic to a catastrophic demise of the dinosaurs by a errant meteor.

The statement, "The paleontologists, traditionally a cautious crew . . . " is a Worlds-in-Collision statement that, broadly translated, states, "The dumb bastards are too stupid to accept my brilliant hypothesis."

By chance, the current issue of *Paleobiology* arrived just after I had finished the article. The lead paper—by Bill Clemens of UC-Berkeley, Dave Archibald of Yale, and Leo Hickey of

the National Museum—is titled, "Out with a Whimper Not a Bang." These paleontologists have been working on the Late Cretaceous extinction problems for a number of years, particularly in the western United States, one of the few places where there is a continuous geologic record through the Cretaceous/Paleocene boundary.

Briefly, the geologic and biologic data indicate that the Late Cretaceous extinctions took place in tens, if not hundreds of thousands, of years. Most of the groups had been on the decline for long periods of time. Many small animals failed to cross the time boundary, including a number of mammals.

I know only one vertebrate paleontologist working with dinosaurs who supports the idea of a catastrophic extinction of these beasts. I suspect that the rest of us are too "cautious" to jump in until the idea has been rigorously tested both geologically and biologically.

J.R. MACDONALD
The Flying Aepinacodon Ranch
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Ladies and Gentlemen,

I do not know who John G. Cramer is. His name rings a slight bell in the back of my mind, but the ringing is very faint. Very faint indeed, compared with the alarm bells ringing in my mind after reading his "guest editorial" entitled "The Territoriality of Space Exploration" (November 9, 1981 *Analog*).

After carefully reading this piece of writing, I cannot, though I would like very much to be kind, shake my opinion of the article, and the allegedly civilized point of view it expresses.

My opinion can be stated in three words: Ridiculous, Foolish, Dangerous.

Firstly, I reject the notion that the American public lost interest in the exploration of space simply because we rejected—note, not failed to carry out, but *rejected*—the notion that a planetary body could be claimed as the property of a minority of Earth's population. It is my belief that the majority of the American public had, by that time in our history, rejected colonialism. Note the period of time in which the landing occurred: the late '60s. The public wrath against our involvement in Vietnam reached such a height that Johnson was publicly humiliated and forced to turn away from his efforts to retain the office of the presidency. At home, some two centuries late, we as a people began to make amends to both American Indians and Blacks for the crimes we committed against them. On every front, social enlightenment was beginning to sweep the land.

Secondly, the notion that such proposed action would have merely resorted in the equivalent of an international squabble is foolhardy—and the notion that any violence that might occur would be confined to the moon is both foolish and ridiculous. As Martin Caidin said, "The moon cannot be defended from space." The irrevocable result of war in space is war on Earth—for until a lunar colony became self-supporting, any base would be totally dependent on its home country. The only sure way of permanently destroying such a colony to the last individual, and making sure that a new colony would not replace it, would be to destroy the ability of the home country to launch such an effort.

This is a fact that we must all recognize and reconcile ourselves to: so long as hostility remains the normal state of affairs between Earth's major military powers, any attempt to colonize space, or anything in space, in such a way that it seems a threat to any of these powers, runs a terrible risk: the risk of war in

a nuclear age.

But to turn back to the question: Why did we lose public support?

There are, I believe, two answers—two simple, interconnecting answers.

In landing on the moon we achieved a goal, one which had been clearly set forth to the nation. Everywhere you turned, on every telecast, in every newspaper, this was the stated goal: to land on the moon and return. Period. Only in science fiction, and a few very vague nonfiction books, was the notion of doing more than just getting up and back explored. The scientific experiments to be performed in future landings, and their importance, were never truly explained to the general public. All the emphasis was on the trip. So once we made it, the national attitude was, from all I saw, that of: "Ho, hum. So what? They already *did* that!"

It is unfortunate, but the laurel wreath goes to he or she who is first. It matters not that the twenty-first has the same struggle, the same obstacles to overcome.

The other factor to consider is the exclusivity of the success. The average man or woman, for example, can understand and share in the success of an athlete, or a team of athletes, if they have at some time played the game. But as long as NASA insists that outer space is the exclusive territory of ex-fighter pilots and scientists, and that the common man—we who pay the freight and who *also* dream of the stars—has no place in it, the space exploration efforts of this country will receive only the most transitory support from the American public.

A couple of years ago, a writer suggested in *OMNI* magazine that NASA raise funds by selling lottery tickets. The prize would be one free, all-expenses-paid trip to space, via the space shuttle. The funds would be used to finance our space effort. It was an excellent idea, for that purpose alone. But even more, the notion that an average, ordinary individual, from any walk of life, could slip the bonds of Earth's oppressive gravity and reach for the stars, would fire such enthusiasm from the public that no elected official would dare say "Hold, enough!"

One must wonder if this is not precisely what NASA—or someone—is afraid of. One must always remember that for every hard-working, dedicated scientist, technician, and astronaut in NASA, there are three bureaucrats and two politicians . . . and they answer to the president, the vice president, and Congress—people who, with rare exceptions, have about as much interest in the good of the nation and its people, and as much foresight, as is necessary to win their next election—while lining their pockets and those of their friends along the way. Or didn't you ever wonder why a person would spend a million dollars to get a job paying fifty thousand a year?

The answer to capturing, or recapturing, public enthusiasm for space exploration is twofold. One: We must, in clear and certain terms, set firm goals, including space stations, lunar bases, L-5 colonies, and manned exploration of other planets and satellites in our solar system. And we must set them forth with such clarity, wealth of detail, and beauty that anyone would say: "Of course!" And we must remind all that each success, each goal accomplished, while magnificent, is only a step to the next.

Two: We must open space to all. No longer should we who believe in space exploration be forced to talk about the benefit to the public of space exploration in terms of transistor radios and heat-

proof baking dishes. It is time—long past time—when every man, woman, and child is told that the stars are theirs, too . . . and just how they will get their chance. If it is necessary, to achieve this goal, perhaps the time has come when it will have become necessary and beneficial to take space exploration out of NASA's hands entirely. Perhaps what we need now is Heinlein's "The Man Who Sold The Moon."

And at all times we must remember that for man to reach the stars, mankind must survive the attempt. International cooperation is not merely an ideal in space exploration—it is the Law of Survival, not only for the individuals who will live in that most hostile of environments, but for all those who shall continue to inhabit Mother Earth.

FRANK HALATEK
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Los Angeles, CA 90046

Dear Sir,

Reginald Bretnor (*Analog*, July 20, 1981) has aroused my sympathy for Samuel Johnson, who declared himself willing to love all mankind except Americans. But I would like to make this reply to his opinions.

Bretnor says that empire has acted to keep the peace. Is he sure? The British fought a few wars just to keep their empire. There was the American war of independence, the Great Mutiny in India, and the Boer War. In the last-named the British herded great numbers of Boer women and children into stinking, unsanitary concentration camps, where thousands of them died. British troops have not been notably successful in keeping the peace in even so small an area as Northern Ireland.

He did say "comparatively," but has he figures to show that there was less warfare while the British Empire existed than there was at other times? He would have to take into account World War I, which was largely a result of rival empires coming into conflict.

And in building their empire, the British exterminated the Tasmanian aborigines and fought the Opium War to force China to buy opium, which the Chinese authorities had been trying to keep out of the country. But Bretnor seems to think there is something specially noble about Anglo-Saxons.

He declares beyond the pale those free "to preach and plan the violent overthrow of the governments or economic systems" of other nations. That brings to mind the destabilization of the Guatemalan government in 1954 and of the Chilean government in 1973, not to mention the Bay of Pigs or Lyndon Johnson's invasion of the Dominican Republic.

He says that cultures are not all of equal value. And a culture willing to wipe out peaceful Asian villages with napalm, which has one of the world's highest crime rates, and which, through the CIA, sponsors the use of torture by various odious Latin American dictators, might be pretty low on the scale.

But basically what soured me on Bretnor's editorial was the underlying assumption that America is without sin, and entitled to cast all the stones (or ICBMs or napalm) it pleases. Granted, instant and everlasting peace would not result if Americans acknowledged that America is just as predatory and dishonest—i.e., as criminal in its foreign relations—as Russia, Libya, or Indonesia. But delusions about America's hands being clean or America's heart being pure are much more dangerous and much farther from reality than any of the ideas that Bretnor denounces.

V.W. TERRILL
Sandringham, Victoria, Australia ■

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11-13 June
DEEPSOUTHCON 20 (Southern regional SF conference) at Northlake Hilton, Atlanta, Ga. Guest of Honor—Karl Edward Wagner; Fan Guest of Honor—Lon Atkins; MC—Kelly Freas. Registration $8. Info: Cliff Biggers, 6045 Summit Wood Drive, Kennesaw GA 30144. (Include S.A.S.E.)

14-17 June
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18-20 June
SF CON 5 (upstate NY SF conference) at Syracuse University, N.Y. Guest of Honor—J. O. Jeppson; Fan Guests of Honor—Pat and Peggy Kennedy; TM—Isaac Asimov. Info: SF Con 5, 337 Harford Road, Syracuse NY 13208. 315-454-3020.

18-20 June
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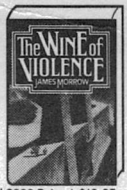

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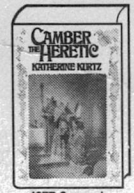

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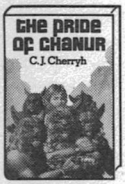

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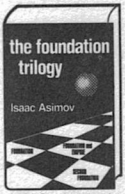

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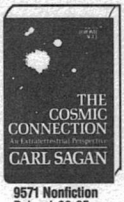

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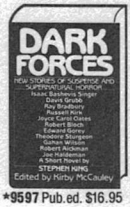

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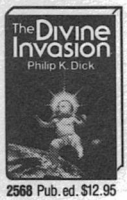

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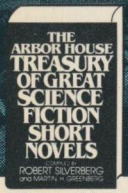

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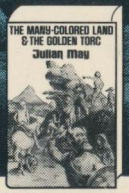

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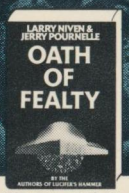

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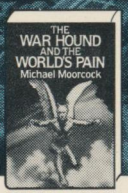

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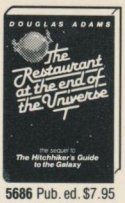

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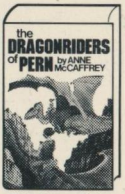

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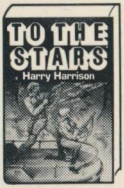

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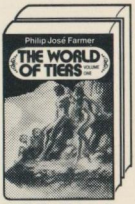

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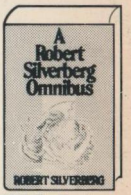

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